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Chemical Engineering

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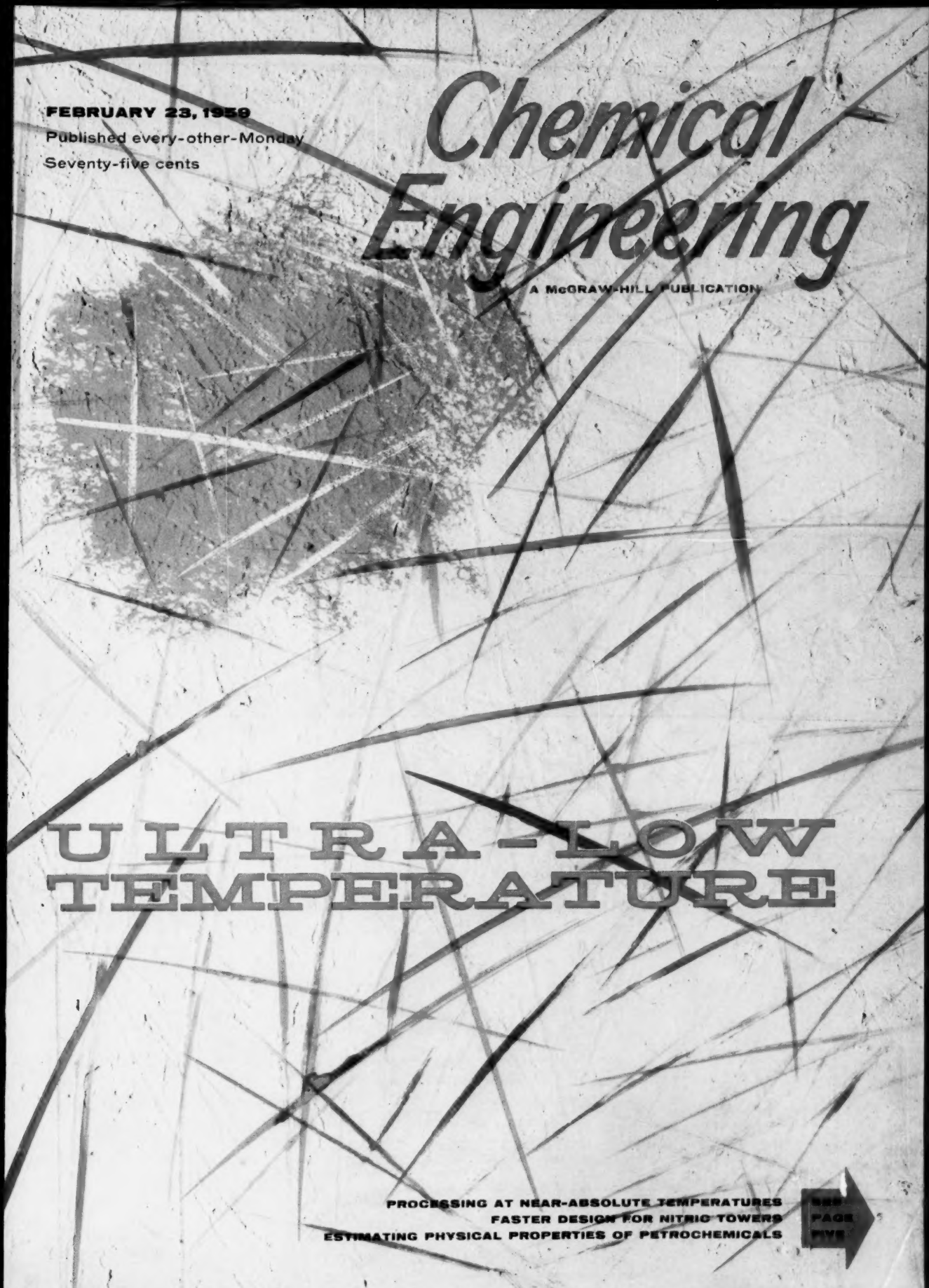

ULTRA-LOW TEMPERATURE

PROCESSING AT NEAR-ABSOLUTE TEMPERATURES
FASTER DESIGN FOR NITRIC TOWERS
ESTIMATING PHYSICAL PROPERTIES OF PETROCHEMICALS

SEE PAGE FIVE

The Shell chemicals listed below are sources of many important commercial products.

Take a closer look in a different light...

A closer look at familiar things in a different light often helps us recognize many interesting and attractive features. This close-up photograph of a diamond in a red light gives us a dramatic new perspective on this familiar gem.

The Shell chemicals in the column at the right may be familiar to you. But a closer look in a different "light" may lead to new and profitable products for your company.

Each of the listed chemicals is used in manufacturing many other important industrial materials. Their reactivity leads to an extensive and growing chemistry that is well worth your investigation. All listed products are available in commercial quantities.

Your Shell Chemical representative will gladly help you take a closer look at the many practical applications of these or other Shell chemicals. Samples and technical literature are available at your request.

Allyl Alcohol
Allyl Chloride
Bisphenol A
Dimethyl Ketone
Epichlorohydrin
Ethyl Amyl Ketone
Hexylene Glycol
Hydrogen Peroxide
Methyl Isobutyl Carbinol

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SHELL

ECO ENGINEERING NEWS

the big name in small pumps for the process industries

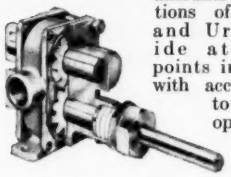
Pumping Notes

Centrifugal Designed as Basic Unit in Multi-plant Standardization Program

ECO's CENTRI-CHEM× was designed to include all the most desirable operating and maintenance features in a centrifugal pump for general chemical service—and mass-produced at a price, making it profitable for any processing plant to standardize upon it. Type 20 Stainless Steel was selected for the ultimate in corrosion resistance and strength. The mechanical seal is chemically inert, non-contaminating TEFLON†, ceramic or carbon. A removable face plate gives access to all internal parts without disturbing piping. Available, motor or pedestal mounted. Capacity to 40 gpm, heads to 50 ft. Priced as low as $184.00 less motor.

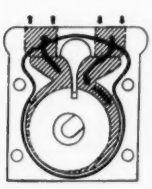
Purifying Uranium

ECO's GEARCHEM× Pumps, providing constant-flow metering with reproducible accuracy within plus or minus one per cent, are employed in a new system for purifying crude Uranium. Several units are already in use here and abroad. These Hastelloy* C pumps, with glass-filled TEFLON gears and bearings, meter exact amounts and concentrations of Hydrochloric and Uranyl Chloride at different points in the system, with accuracy essential to its successful operation.



Pumping Shear-Sensitive Fluids and Missile Grade Propellants

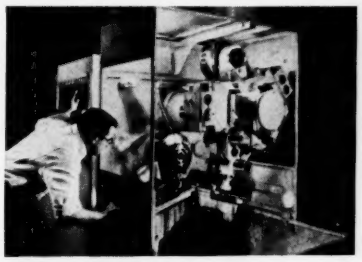
For pumping without mechanically disrupting fluid balance—ECO's ALL-CHEM× rotary displacement pump with its non-shearing, smooth, positive thrust of two axially opposed oscillating impellers producing two overlapping discharge and suction strokes per revolution, provides an almost pulseless flow essential to safe pumping of such media as hydrogen peroxide, hydrazine, nitroglycerine, etc. Also, in handling such fluids as missile grade propellants, subject to internal spark and explosive wave propagation, these pumps are widely preferred, since their self-lubricating TEFLON impellers and bearings eliminate internal spark hazard.



The Responsibility of Leadership

How ECO Builds Better Chemical Pumps at Lower Costs

Eco Engineering Company's position of leadership in the small chemical pump field is primarily the result of advanced engineering and an open mind to the new and improved materials of construction which have revolutionized design possibilities and service expectations. In this connection Eco has pooled the vast materials engineering research of such companies as du Pont, International Nickel, Carpenter Steel, Union Carbide, U. S. Graphite, Carborundum and other outstanding suppliers with their own broad pump manufacturing and application experience to produce their unique and diversified line of rotary, gear and centrifugal pumps for corrosive service.

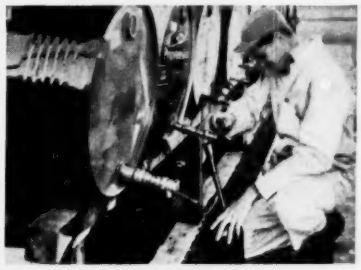


Automatic "Program" Machining

But building better chemical pumps was not sufficient. Eco insisted their line be lower in first cost as well as in upkeep than pumps of comparable quality. Mass production on the most modern automatic "program" machine tools, where multiple operations are performed to reduce needless labor and handling, was their answer to this requirement.

Standardization and Interchangeability

All Eco pumps were designed for precision manufacture with standardization of every component part for interchangeability in original assembly or replacement in the field. Interchangeability of parts and mass production has had another important value to the user. It has permitted manufacture and stocking of a highly flexible inventory to provide immediate delivery of any "specification pump" in the Eco line, as well as a variety of specification variations to meet individual customer needs.



Factory Mutual Approved Chemical Faucet

This Eco Stainless Steel Chemical Faucet is the ultimate for safely dispensing flammable and corrosive fluids. It is the only fume-tight, spring-loaded faucet with TEFLON seals which overcome seizure problems. Ideal for drum dispensing or for standard piping systems. Illustration shows solvent storage area at Eastman Kodak, Rochester plant, where more than 200 Eco Faucets are in use.

TEFLON T-Film× Hydraulic Sealant

Eco's chemically-inert thread sealant and anti-seize compound for metal, plastic, carbon and ceramic systems and equipment was produced originally as an aid to Eco pump users in the nuclear and corrosive chemical fields. After four years of highly successful use, T-Film is now in general use throughout the process industries wherever corrosives are encountered.

ECO Products for Handling Corrosive and Hazardous Processing Fluids

ALL-CHEM Rotary Pumps
MINILAB Rotary Pumps
GEARCHEM Gear Pumps
CENTRI-CHEM Centrifugal Pumps
PUMPMOBILE Portable Pumping Units
CHEMICAL FAUCETS Factory Mutual Approved

Ask for literature on any or all of these ECO Products

×ECO Trademarks. †du Pont Trademark. *Union Carbide Trademark.

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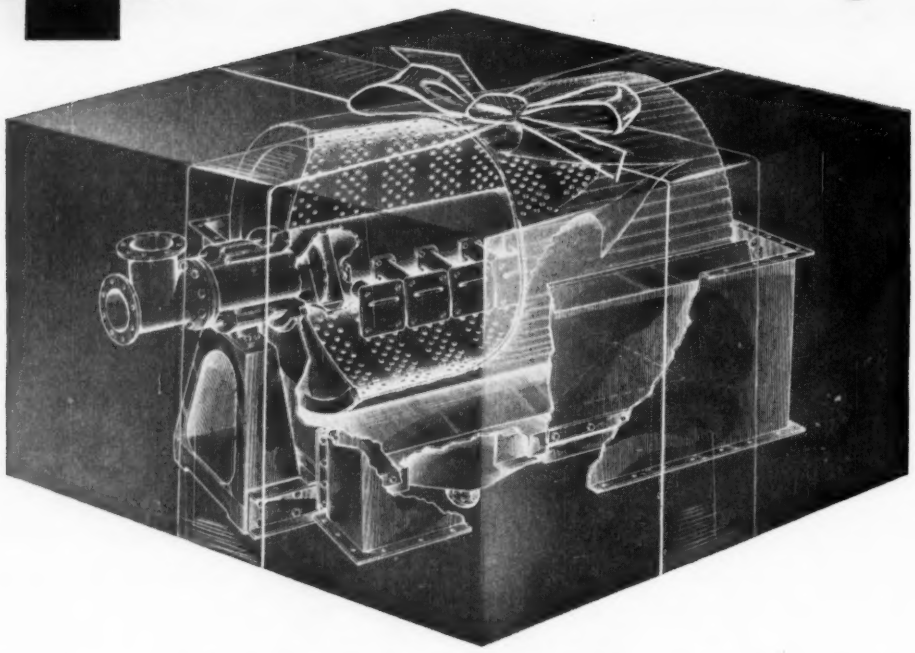
4 *money-making, money-saving Filtration Advantages*



Wrapped up in One Small Package

1. HIGH OUTPUT

The BIRD-YOUNG Vacuum Filter gives you as much as six to ten times the capacity per foot of filter area as the ordinary drum filter.

Look at the "ghost" drawing and you'll see why. Virtually the entire drum is under vacuum. Filtrate flow is unhampered by pipe lines or valves. The slotted shoes pulsate low pressure air for high effective cake removal. Slow filtering solids can be handled at high drum speeds.

2. DRY CAKE

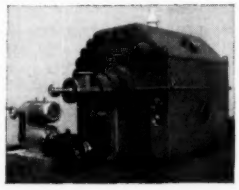
BIRD-YOUNG construction brings full pump vacuum directly under the filter medium and over almost every inch of the drum surface.

3. SUPER-EFFICIENT WASH

BIRD-YOUNG design provides for multi-stage, counter-current washing with sharp separation of each wash liquor from the filtrate.

4. FUME TIGHT

BIRD-YOUNG design permits positive closing of the complete fume or vapor sealing.



Before you invest in vacuum filtration of any kind, however time-honored or seemingly satisfactory, find out how much better the Bird-Young Filter can do the job in terms of production, product quality and net cost per ton. The Bird Research and Development Center offers complete pilot-scale test facilities.

BIRD YOUNG FILTERS

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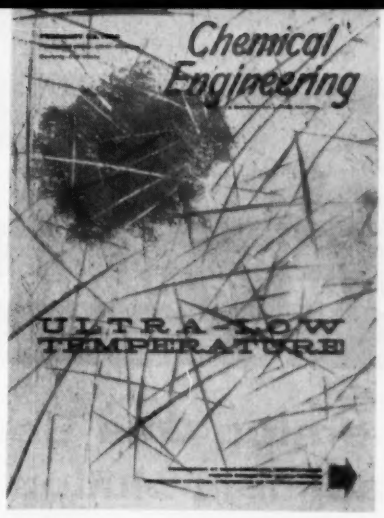

FOURTH OF TWENTY-SIX 1959 ISSUES

4/26

What's new in cryogenics

Oxygen purification, methane liquefaction, helium production—these and other products and processes need the special equipment and techniques of ultra-low-temperature engineering. Here's an up-to-the-minute rundown on what's going on in this field today: applications, processes, materials of construction, equipment, storage, transportation, safety. (p. 123)

Design data for oxides of nitrogen

If you're dealing with reaction or equilibrium data of nitrogen oxides, this method will cut your calculating time by at least one-quarter. And whether your problems are rocket fuels, nitric acid or air pollution, these six charts convert physical chemical data into engineering answers. (p. 139)

New help for petrochemical researchers

Seven new equations will help you to estimate properties of petrochemicals—accurately. They give a reliable new route that research and design engineers can take. With only two known properties it's now possible to come up with at least three others. (p. 147)

How engineers can save on income tax

Now's the time to take advantage of the new income tax regulations. So our authoritative guide to provisions should benefit all employed engineers. And the checklist can steer you to money-saving use of Form 1040. (p. 156)

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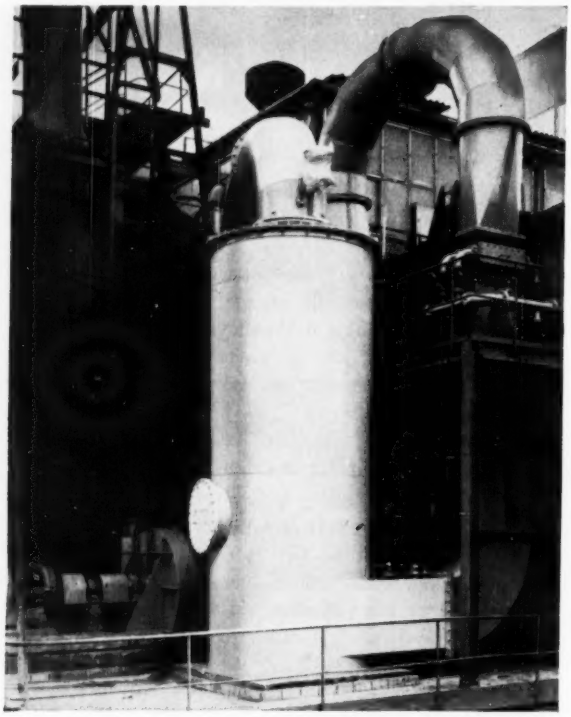
AIR POLLUTION

growing problem in the chemical industry

Chemico Gas Scrubbers offer practical solution in variety of CPI applications



The Chemico venturi scrubber installed on this phosphoric acid plant removes and recovers better than 99% of the phosphoric acid mist. In this instance, both venturi and cyclonic separator are rubber-lined to withstand the effects of the acid.

FULL DETAILS AVAILABLE

For your copy of a new brochure giving complete data on Chemico venturi gas scrubbers or for technical assistance on a specific problem, write to the address below.

Dusts, fumes and mists—the unavoidable by-products of many industrial processes—often create tremendous public relations and legal problems. The chemical industry is now taking vigorous steps to remove these nuisances.

One such step has been the application of Chemico venturi gas scrubbers which remove sub-micron as well as plus-micron particles from gas streams, thereby eliminating the polluting elements. These units are based on the Pease-Anthony venturi principle which has been modified and improved by Chemico.

• • •

OUTSTANDING PERFORMANCE ON DIFFICULT PROBLEMS

Typical of the success of Chemico venturi gas scrubbers has been their recent application to sulfuric acid concentrators which have long been a source of air pollution. By the use of this equipment, better than 99% of the acid mist can now be removed, thus solving this difficult pollution problem.

SIMPLE CONSTRUCTION PERMITS WIDE APPLICATION

The simple design of Chemico venturi gas scrubbers allows for use of materials resistant to corrosion, abrasion or high temperature. This, plus their small space requirements, permits installation in existing plants handling corrosive materials as well as incorporation into new plant designs. In addition, no critical controls are required and maintenance costs are reduced to the barest minimum. Chemico venturi scrubbers have been proven for use in acid concentrators, copperas roasting kilns, chlorosulfonic acid plants, dry ice plants, phosphoric acid plants and many other chemical manufacturing operations. These are the same scrubbers which won such wide acceptance in the iron and steel industries.

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Chemical Engineering

FEBRUARY 23, 1959 **Vol. 66 No. 4**

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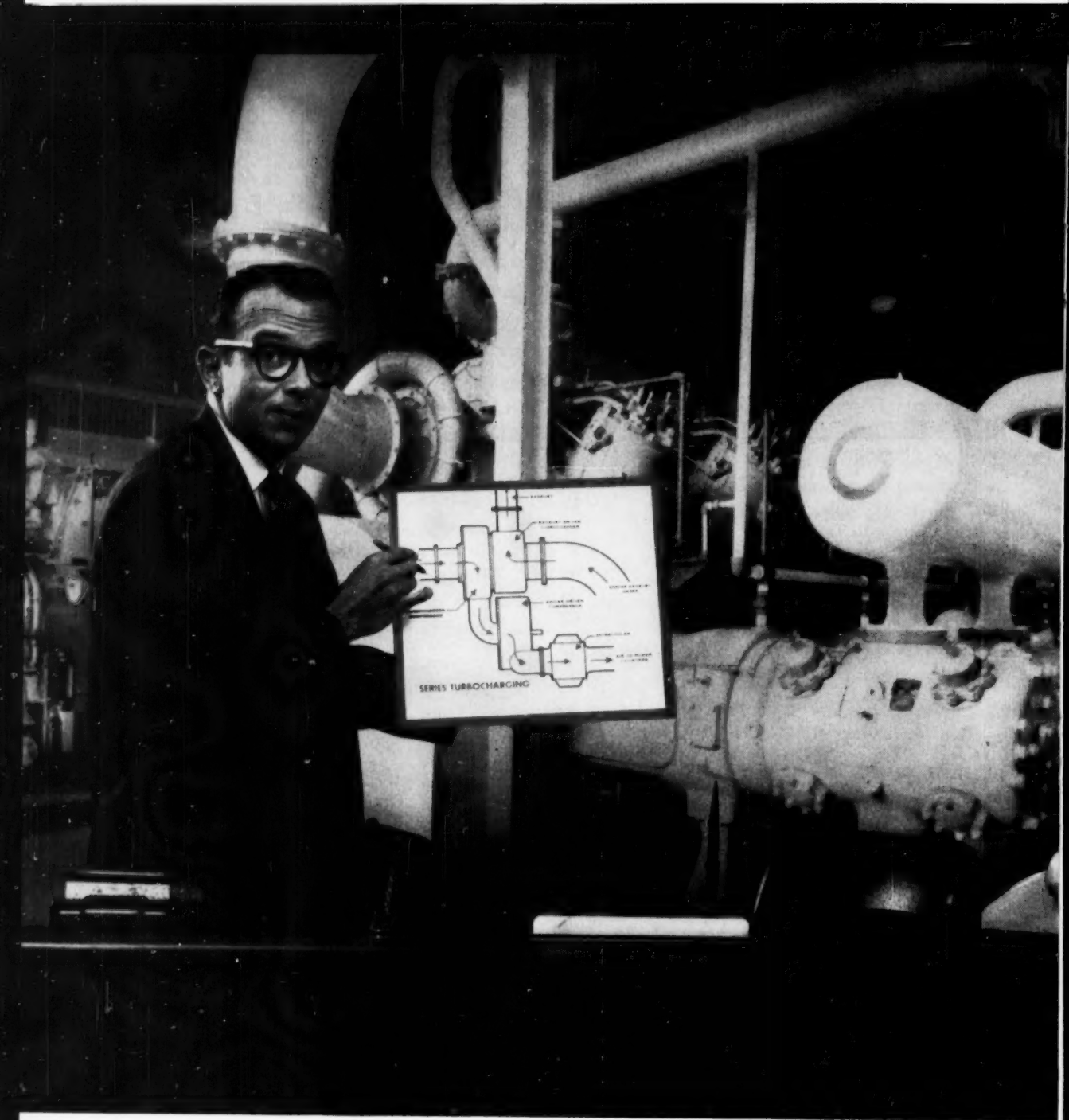
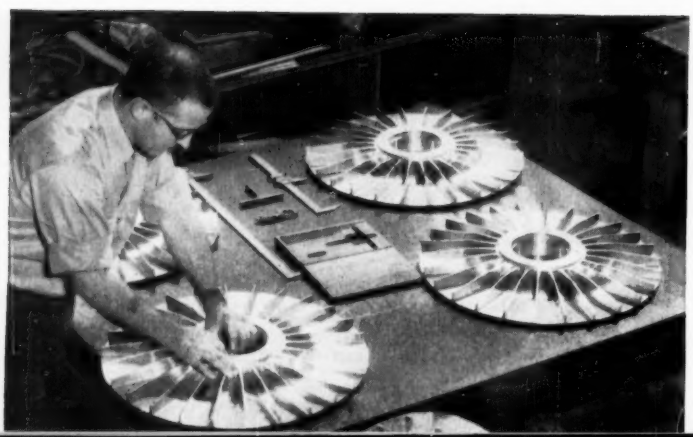
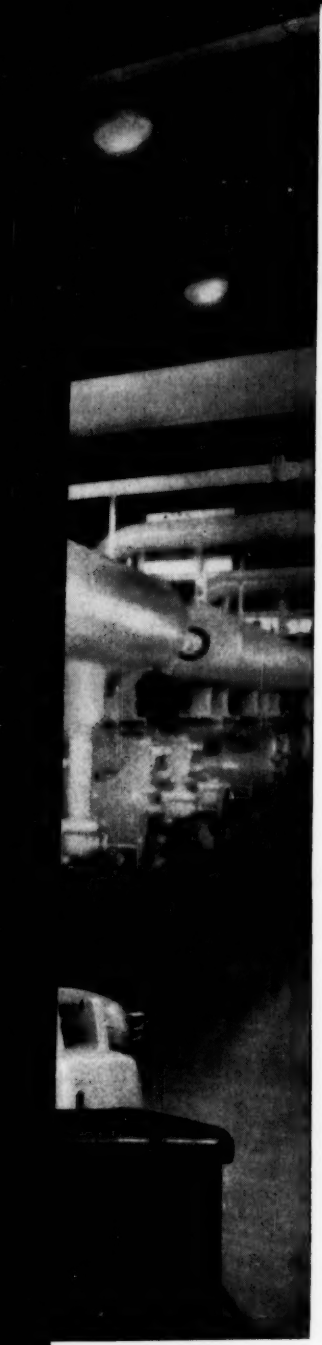




Built Entirely By Cooper-Bessemer. Cooper-Bessemer is able to ideally integrate turbocharger system and compressor engine performance . . . and to assure highest standards of materials and workmanship for these precision components.



Donald L. Reed, *Manager Gas Engine Compressor Sales, The Cooper-Bessemer Corporation, explains . . .*

How you get 40% more power with the latest Cooper-Bessemer V-Angle Compressors

The diagram explains Cooper-Bessemer's series turbocharging development. A step beyond ordinary turbocharging, *series turbocharging* assures an extra performance margin throughout the operating range, plus these unmatched advantages:

40% greater horsepower than predecessors of the same bore, stroke and speed.

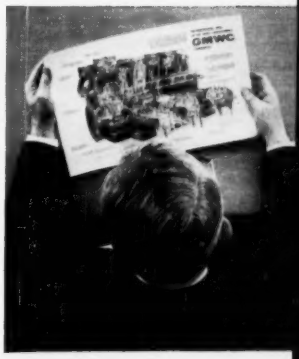
Reduced fuel consumption . . . as low as 6900 Btu/bhp/hr—proof of series turbocharging's greater efficiency.

Space savings. Greater output, combined with inherent compactness of V-angle design, results in lowest cost per horsepower for housing, foundation, piping, maintenance, supervision.

Superior altitude performance. Inherent flexibility of the series turbocharging system allows unique altitude compensation to assure full rated horsepower and highest efficiency.

Full range response. The Cooper-Bessemer series turbocharging principle *automatically* provides optimum supercharging regardless of the degree of load.

WRITE FOR BULLETINS . . . complete details on Cooper-Bessemer Series Turbocharged V-Angle Compressors in GMVC Bulletin 85 and GMWC Bulletin 86. Free on request.



Latest Bulletins. GMVC Bulletin 85, 1100 to 1800 bhp; GMWC Bulletin 86, 2000 to 3500 bhp.

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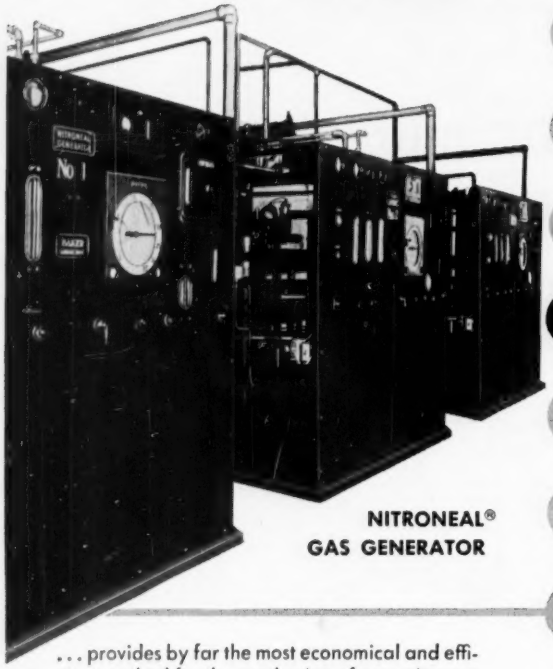

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GAS GENERATOR

. . . provides by far the most economical and efficient method for the production of pure nitrogen —*completely free of oxygen*—and with hydrogen content precisely controlled at any desired percentage between 0.5% and 25%. Nitrogen is supplied at a fraction of cylinder supply cost.

The Nitroneal Generator is automatic except for startup, with no need for operating personnel. The unit performs instantly, efficiently anywhere in the range of from 25% to 100% of rated capacity. Installation requires only a 110 volt line, water, air, ammonia lines and drain facilities. Units can be supplied in capacities of 100 cfh to 10,000 cfh. . . . The catalyst lasts indefinitely—maintenance costs are practically nil. Write for complete catalog material and data.

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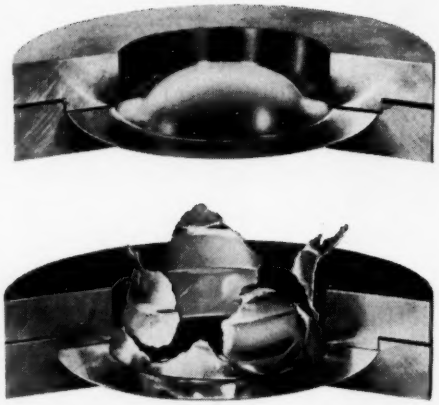

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In pressurized apparatus subject to corrosive action, precious metal rupture discs provide the safest, most accurate and dependable relief. Platinum, gold, and silver are now generally recognized as specifics when dealing with corrosion. Each is resistant to the corrosive effects of an important group of liquids and gases and will remain unattacked under conditions that would render many base metal materials useless. These rupture discs, depending on material selected, are guaranteed to be burst ± 5% of specified pressure. Intrinsic value adds to the original cost of these discs but the actual metal value is recovered, no matter how torn or battered the discs may be. Send for Bulletin.

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ENGELHARD INDUSTRIES, INC.

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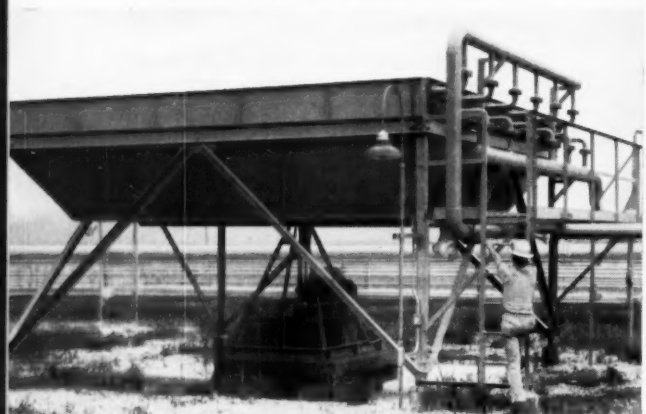
113 ASTOR STREET • NEWARK 2, NEW JERSEY

BAKER PLATINUM DIVISION

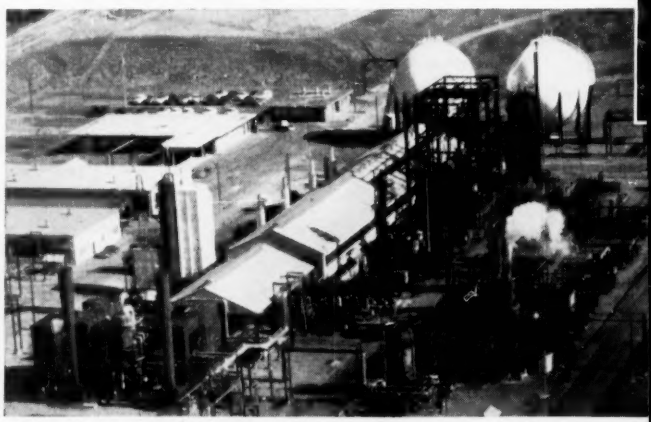
5 process heat solved with Trane

Air Reduction Company designed its Butler, Pennsylvania liquid oxygen plant around TRANE Brazed Aluminum Heat Exchangers, *obtaining efficient, economical heat exchange.* In this cold box, air and nitrogen streams are reversed on a 10-minute cycle to clean up condensed water, ice, CO^2 and other impurities.

Foster Wheeler Corporation designed this synthetic nitrogen plant for Deere & Company. They report that the TRANE Heat Exchange equipment *has operated four years without trouble of any kind.*



Many refineries solve water problems by *air-cooling* liquids, gases and condensing vapors with TRANE Fluid Coolers. Also widely used in chemical, petroleum and natural gasoline plants, TRANE Air Coolers cut real estate costs and maintenance expense. And while they cost no more than other types of cooling equipment, they have a far greater life expectancy.



Spencer Chemical's Vicksburg, Mississippi plant has achieved more economical production of ammonia and related chemicals with the Texaco-HRI methane process—using TRANE Brazed Aluminum Heat Exchangers. Temperature approaches as close as 5° F *reduce power costs for refrigeration;* compact design cuts space and construction costs.

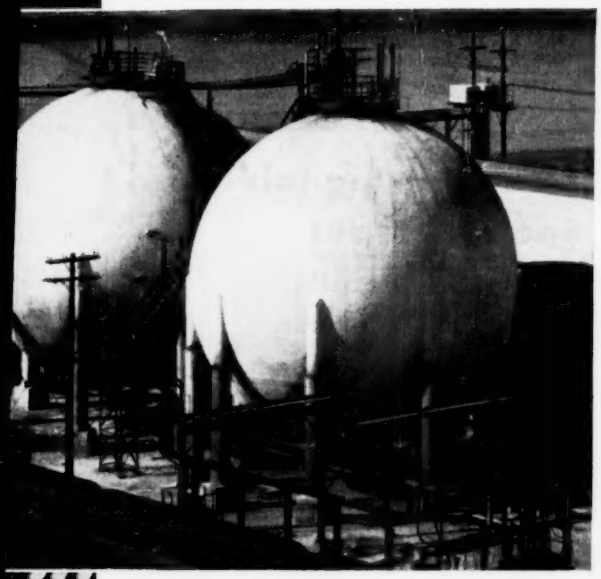
transfer problems Heat Exchangers

Every year, more and more plants are relying on TRANE Heat Transfer equipment for a wide variety of process applications. These plants report that TRANE Heat Transfer equipment helps them in five important ways:

- **Reduced refrigeration costs**
- **Close temperature approaches**
- **Efficient, economical heat exchange**
- **Trouble-free operation**
- **Elimination of water problems (with TRANE Fluid Coolers)**

TRANE Brazed Aluminum Heat Exchange equipment is lightweight, compact—packs 450 sq. ft. of heat exchange surface into 1 cubic foot. Its performance characteristics give you temperature approaches as close as 5° F. Rugged and dependable, it withstands operating pressures as high as 600 psig. And you cut space and construction costs, too, because a typical cold box with TRANE Brazed Aluminum Exchangers requires only *half as much space* as one with conventional heat transfer equipment!

If you have a process heat transfer problem, turn to TRANE. Over thirty years of varied heat transfer experience is at your service! Ask your TRANE Sales Office for information, or write directly to TRANE, La Crosse, Wisconsin.



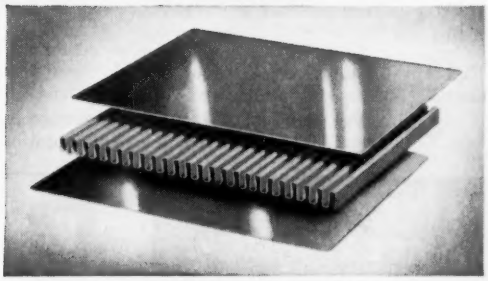
For any air condition, turn to

TRANE

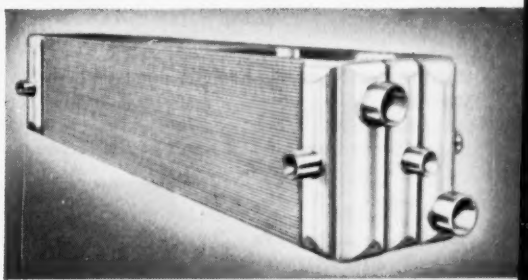
MANUFACTURING ENGINEERS OF AIR CONDITIONING, HEATING, VENTILATING AND HEAT TRANSFER EQUIPMENT

THE TRANE COMPANY, LA CROSSE, WIS. • SCRANTON MFG. DIV., SCRANTON, PA. • CLARKSVILLE MFG. DIV., CLARKSVILLE, TENN. • TRANE COMPANY OF CANADA, LIMITED, TORONTO • 97 U. S. AND 18 CANADIAN OFFICES

The Atlantic Refining Company reports *temperature approaches of 5° F* plus 99.99% pure anhydrous ammonia in their Philadelphia plant—using fifty TRANE Brazed Aluminum Heat Exchangers.



Lightweight, compact TRANE Brazed Aluminum consists of corrugated aluminum sheets brazed together to form a stack of layers which form individual passages for the flow of fluids or gasses. Provides up to *nine times* the surface per square foot of shell-and-tube exchangers!

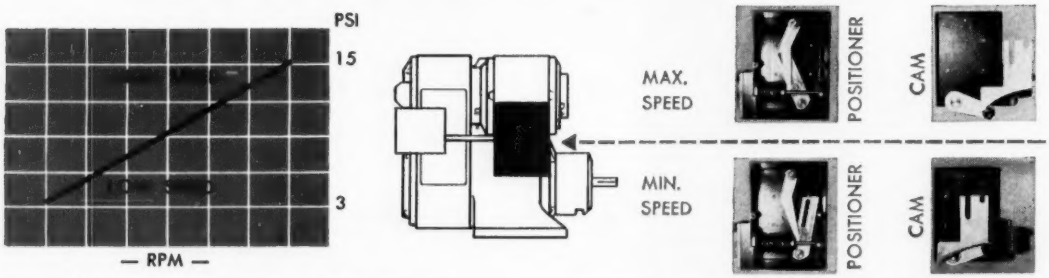


Headered for 5-stream operation, this TRANE Brazed Aluminum Heat Exchanger can handle as many as five fluids simultaneously. Units are available for either cross-flow or counter-flow operation. Surface can be fabricated in a wide variety of shapes and sizes to meet all types of requirements.

REEVES

AUTOMATIC PROCESS CONTROL
with
Vari-Speed Motodrives

Sensitive Speed Reaction to Controller Signals ... Straight Line Variable Speed Output



• REEVES AIRtrol, in an open or closed loop system, automatically and continuously corrects operating speeds to compensate for variations in materials or energy (i.e. temperature, liquid level, density or flow).

As the final control element, the pneumatically-controlled Motodrive assures sensitive and stable control throughout the speed range.

Linear speed output is a result of the exclusive cam design. The AIRtrol responds to a 3 to 15 p.s.i. pneumatic signal, and is adaptable to all standard process instrumentation.

The AIRtrol is available on all REEVES Motodrives . . . hundreds of assemblies from ¼ through 40 hp., 2:1 through 10:1 speed range, and 1.7 through 4660 rpm.

For examples of AIRtrol in process control systems, write Dept. CE 39 for AIRtrol Instrumentation Data Sheets.

VARI-SPEED MOTODRIVE
VARI-SPEED MOTOR PULLEY
VARIABLE SPEED TRANSMISSION

REEVES PULLEY COMPANY
Division of RELIANCE ELECTRIC AND ENGINEERING CO.
COLUMBUS, INDIANA
In Canada: Reeves Drives • Toronto • Montreal

R MASTER REEVES

as protective as a catcher's mask!

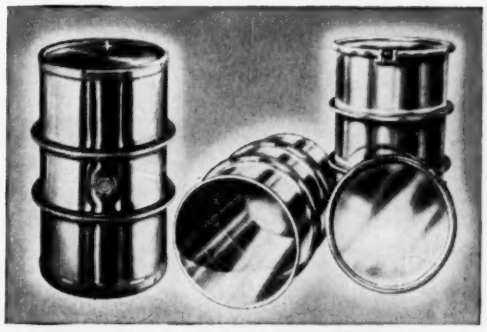
Protection against product discoloration... chemical changes... corrosive action

Is container neutrality of prime importance in shipping or storing your products? *Hackney Alloy Metal Drums* offer a proved solution.

Hackney Stainless Steel Drums are widely used to ship and store nitric acid, phosphoric acid, acetic acid, solvents formaldehyde, inks, food concentrates and many other products.

Hackney Nickel and Monel Metal Drums are frequently used to transport and store products such as phosphorous trichloride and other chemicals required for shipment in ICC-5K nickel drums. Monel drums are used primarily for shipment of liquid bromine.

Hackney Metal Drums are available with plain sides or I-bar rolling hoops; welded chimes; smooth bottoms with substantial foot rings; crack- and crevice-free, easy-to-clean interiors.



Stainless steel drums, with removable heads, come in 30- and 55-gallon capacities; drums with tight heads, 55-gallon capacities. For specifications of stainless, nickel and Monel drums, write:

Pressed Steel Tank Company

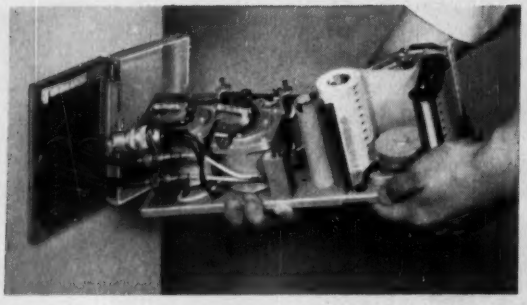
Manufacturer of Hackney Products

1447 South 66th Street, Milwaukee 14, Wisconsin

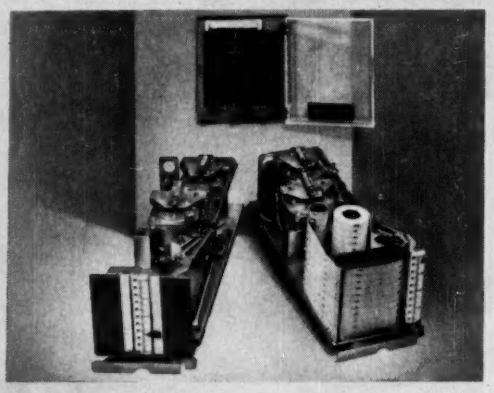
Branch offices in all principal cities

CONTAINERS AND PRESSURE VESSELS FOR GASES, LIQUIDS AND SOLIDS

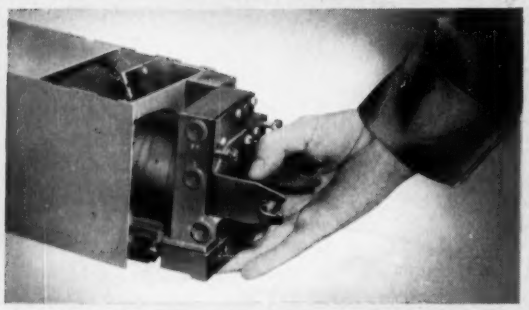
Hackney



Easily Serviced—All parts can be inspected during operation, without process interruption. To remove chassis completely, unscrew three finger-tight, self-sealing connections.

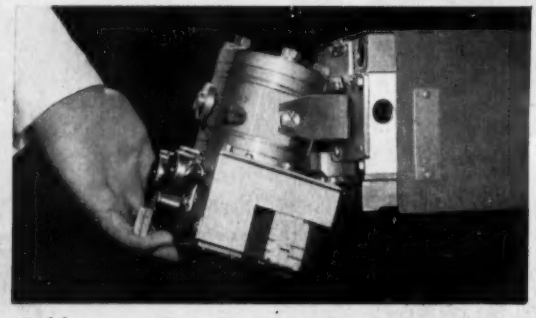


Interchangeable Chassis—Change recorder to indicator or vice versa without interrupting control. Simply pull out chassis, slide another in place.

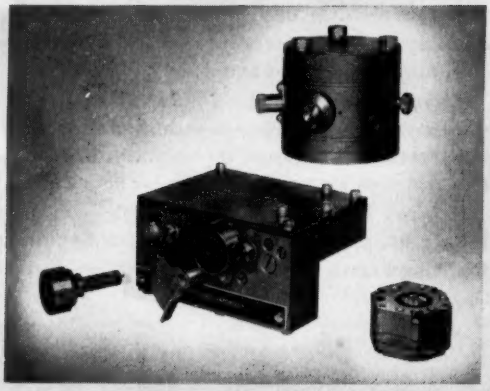


Removable Regulator—Pneumatic assembly, consisting of regulator and switches, can be removed from rear of case without disturbing electrical connections—no need for an electrician to stand by.

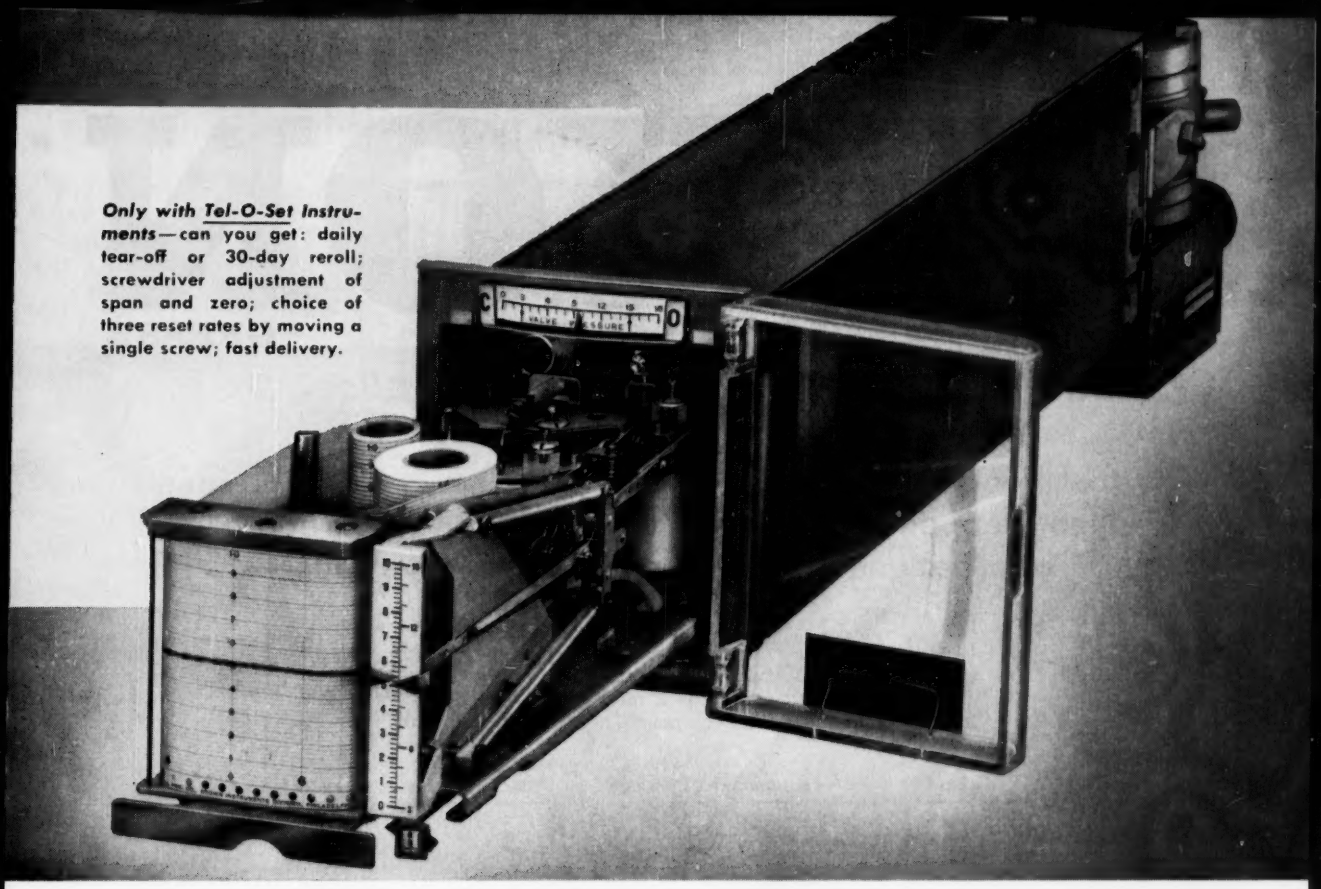
Now you can gain ... Extra



Quick-connect Mounting—Controllers have quick-connect switch permitting removal of the unit while process remains on manual control.



Easily Disassembled—Unitized construction of all controller components simplifies maintenance . . . makes reassembly foolproof. No need to dismantle stack to clean pilot assembly.


Only with Tel-O-Set Instruments—can you get: daily tear-off or 30-day reroll; screwdriver adjustment of span and zero; choice of three reset rates by moving a single screw; fast delivery.

Savings with TEL-O-SET*

. . . advanced miniature pneumatic instruments

Tel-O-Set miniature instruments accurately record, indicate, and control process variables. They're applicable to any process variable . . . a saving in itself. And, further savings are accrued from these factors: Only a few models are needed for *all* applications . . . Personnel training time is minimized . . . Spare parts inventory is reduced . . . Process techniques can be changed without buying new instruments. The photographs point up some of the outstanding *Tel-O-Set* features.

For complete information on *Tel-O-Set* instruments, write for Catalog C 100-1a, or call your nearby Honeywell field engineer. He's as near as your phone.

MINNEAPOLIS-HONEYWELL, Wayne and Windrim Avenues, Philadelphia 44, Pa.

*Trade name Minneapolis-Honeywell Regulator Co.

Honeywell

H HONEYWELL

First in Control

How

RYKON

GREASE

has performed in seven tough applications

In just two years since introduction, **RYKON** Grease has stepped in to deliver lubrication in hundreds of applications where other greases have failed

1

2

3

4

In the process industries where higher speeds, loads, temperatures and pressures are being put on bearings as a means of increasing productivity of equipment, a new type of grease has been needed. RYKON is that grease. Here are just seven examples of how RYKON Grease has performed in tough spots:

Industry	Equipment	Type of Bearings	Conditions	Remarks
Packing Company	can closers	various	high temperature, heavy load, wet	Outperforms previously used greases.
Brewery	washers, conveyors	various	high temperature, wet	Lasts longer and does a far better job on all applications.
Packing Company	canning machines	plain and anti-friction	wet	Very satisfactory.
Chemical Laboratory	washers and degreasers	anti-friction	wet	Better than any grease tested in degreasing solvent.
Automotive Parts Mfr.	reciprocating pump bearings	plain	wet	Pumping chemicals. O.K. after one month. Previous grease caused about one bearing failure per week.
Paper Mfr.	liquid sulfur pump	anti-friction	high temperature, wet	Has extended life of bearings.
Paper Carton Mfr.	all grease-lubricated parts	various	high temperature, heavy load, wet	Replaced eight different greases. Stays in better.

The reason RYKON Grease can perform under conditions that cause other greases to fail is this: RYKON Grease has a unique non-soap, organic thickener. This thickener holds the oil between its fibers better than any other gelling agent. The thickener is able to withstand extremely high as well as low temperatures. It resists chemical action and remains stable under conditions of severe working and water washing. RYKON Grease has exceptional anti-rust properties.

RYKON Grease's unique properties make it truly multi-purpose. This leads to many worthwhile economies. With one grease to do possibly every grease lubrication job in a plant, there's no chance for application mistakes. Inventory and handling of many single-purpose greases is reduced or eliminated and maintenance training and supervisory follow-up is greatly reduced.

More facts about RYKON Grease are yours for the asking. Call the lubrication specialist in your nearby Standard Oil office in any of the 15 Midwest and Rocky Mountain states. Or write **Standard Oil Company (Indiana), 910 S. Michigan Ave., Chicago 80, Illinois.**

You expect more from **STANDARD** *and you get it!*

Oven test shows high temperature performance of RYKON Grease. 1. Metal panel coated with RYKON and placed in oven at 350° F. 2. Same panel after five days. RYKON is still soft and ready to lubricate. 3. Another high-melt grease ready for same test. 4. Same panel after oven test. Grease has failed completely.

where trouble-free performance is a matter of pride...

DOW CHEMICAL COMPANY, TEXAS DIVISION, FREEPORT, TEXAS

SCOVILL

Heat exchanger tube

One of the largest of The Dow Chemical Company's manufacturing installations is the Texas Division, where, in complex and brilliantly-painted plants hundreds of different components are processed and re-shaped to produce more than 40 fundamental chemical products.

Chemical process condensers such as this at The Dow Plant, Freeport, Texas, are vital links in the production chain and are tubed with Cupro-Nickel, 30% Heat Exchanger Tubes.

Combining excellent corrosion-resistant properties with very favorable mechanical properties, Scovill Tubes of this alloy make an important contribution to the trouble-free operation of these key units under very exacting service conditions.

Let Scovill Technical Service . . . most experienced in the field . . . help you establish the best heat exchanger tube specifications for equally trouble-free service in your own heat transfer equipment.

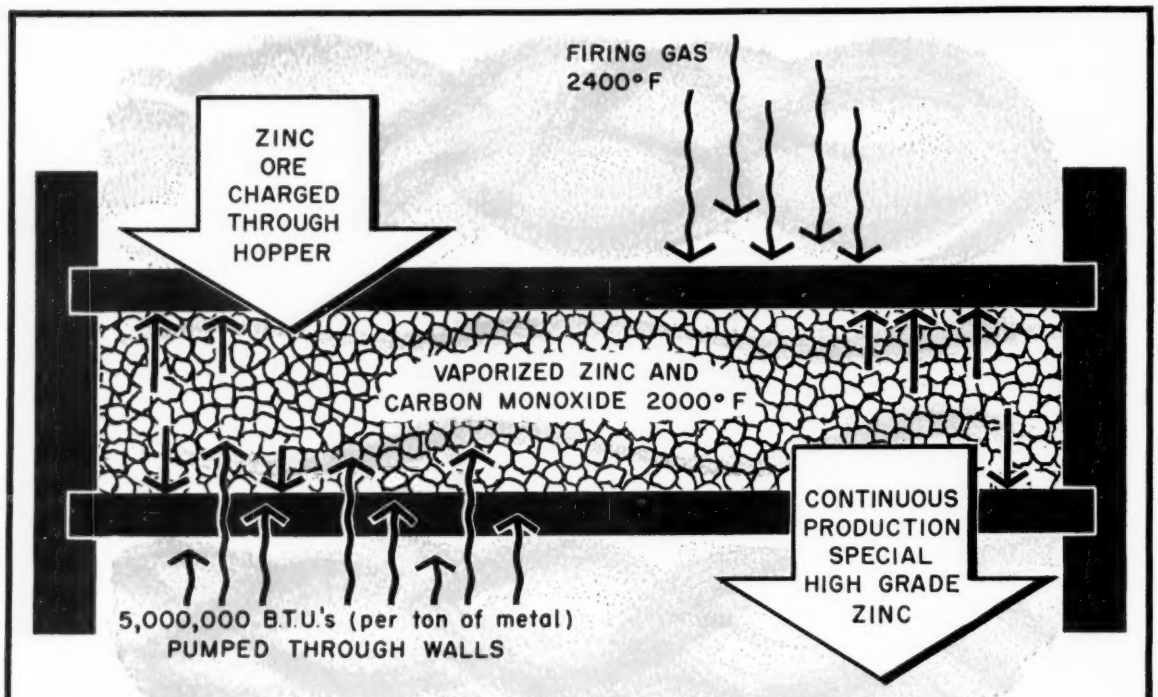
MADE IN U.S.A.
TO THE STANDARDS
OF AMERICAN INDUSTRY

HEAT EXCHANGER TUBE for Applications from Marine to Petrochemical, from Compressor Intercoolers to "Cat-Cracker" Exchangers, in these popular Alloys . . . Phosphorized Admiralty • Admiralty • Arsenical Admiralty • Red Brass, 85% • Deoxidized Copper • Arsenical Copper • Cupro-Nickel, 10%-20%-30% • Aluminum Brass • Aluminum Bronze, 5% • Muntz Metal • Duplex Tube

SCOVILL MANUFACTURING COMPANY, Mill Products Division, 99 Mill Street, Waterbury 20, Connecticut. Phone PLaza 4-1171.

9SC58

It was done with Carborundum's Super Refractories:



Gas-tight walls resist the action of zinc vapor and CO... transmit 5,000,000 BTU/ton of metal

A combination of heat, pressure, wear and corrosion in New Jersey Zinc's vertical retort process for the continuous reduction of special high-grade zinc presented a difficult job for Super Refractories by Carborundum.

This process requires a structural material with high heat conductivity, low permeability to contain the gas-vapor mixture, and high strength at very high temperatures. It must also be chemically inert to the combusted gases outside and the reduction products inside the retort.

One of Carborundum's Super Refractories—CARBOFRAX® silicon carbide refractory—met these tough requirements. It has high thermal conductivity (11 times better than fire-clay), almost complete impermeability to gases (2 cu ft of cold air/hr/sq ft/inch of thickness, at 1" water pressure), exceptional load-bearing strength at high temperatures (300 psi at 2750° F without crushing). CARBOFRAX bricks are chemically inert, too (they resist most acids, acid sludges and fluxes, zinc oxide or vaporized zinc), and are highly resistant to abrasion (grinding wheels are made of silicon carbide).

If you have a problem that even the best of standard refractories or metals won't handle, consider Carborundum's Super Refractories. There is a wide range of products, each with a combination of properties seldom found in other materials.

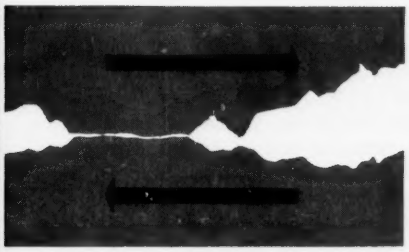
Write today for your free copy of "Super Refractories by Carborundum." The address: Dept. H-29, Refractories Division, Perth Amboy, New Jersey.

CARBORUNDUM
Registered Trade Mark

WHY VALVE LUBRICATION SAVES MONEY

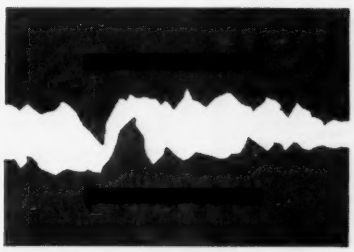
TROUBLE STARTS WHEN METAL RUBS METAL...

Under the microscope, metal that appears mirror-smooth to the naked eye shows as sharp mountains and deep valleys. This roughness, combined with the heat and pressure of metal-to-metal rubbing, causes valve trouble in the following ways:



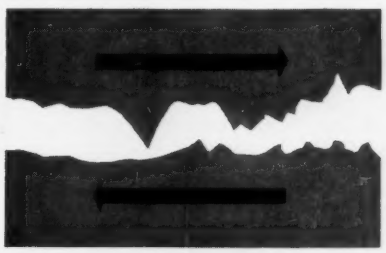
STICKING

"Cold Welding" occurs when friction or pressure welds the peaks together. The result: sticking.



SHEARING

The "hills" of one surface gouge into the hills of the other surface causing further sticking and scoring.

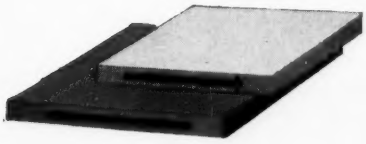


PLOWING

If one surface is even slightly harder than the other, the hard peaks act like a "plow". Leakage soon results.

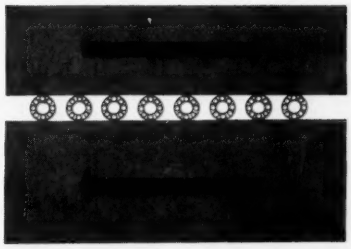
BUT, WITH ROCKWELL-NORDSTROM VALVE LUBRICATION...

metal-to-metal contact is eliminated. Here's what happens when metal-to-metal surfaces are lubricated:



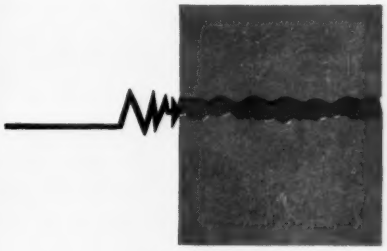
SLIDING

Lubricant prevents friction heat, eliminating danger of cold welding and assuring easy movement.



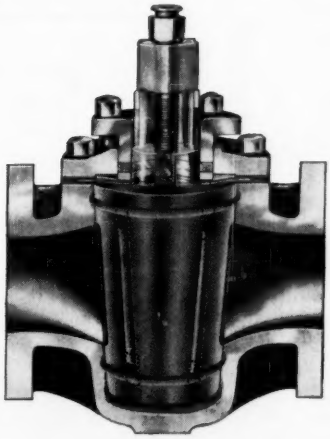
ROLLING

Lubricant becomes millions of tiny bearings . . . metal surfaces actually never come into contact with one another.



SEALING

Pressurized lubricant forms an impenetrable, continuous seal against leakage.



LONGER LIFE, LOWER COST, better valve service results when you specify Rockwell-Nordstrom lubricated plug valves. Notice in the drawing at the left how lubricant protects all the working surfaces and seals positively against leakage. Since lubricant eliminates adhesion, shearing and plowing, Rockwell-Nordstrom valves cost you less to use . . . year after year. Rockwell-Nordstrom valves are available in a complete range of sizes and pressure ratings to answer every flow control need. They cost no more to buy, often less, than ordinary valves. See your nearest supplier or write Rockwell Manufacturing Company, Pittsburgh 8, Pa. for complete details.

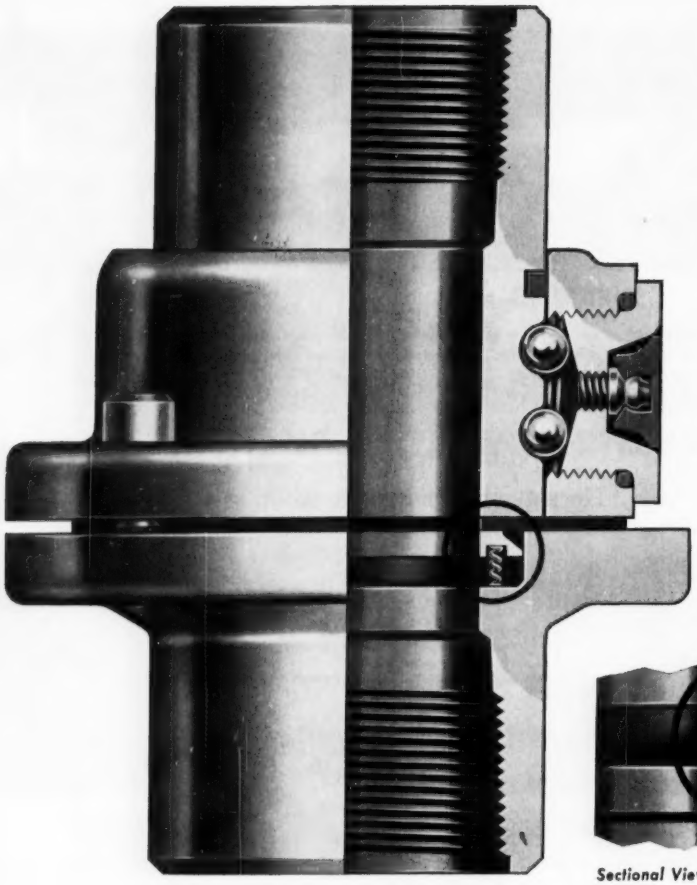
Canadian Valve Licensee: Peacock Brothers Limited

ROCKWELL-Nordstrom VALVES

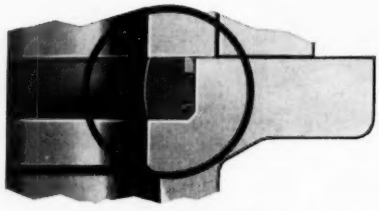
it's ROCKWELL

MANUFACTURING COMPANY

For Trouble-Free Flexibility on Steam, Hot Gas, Chemical Service Lines

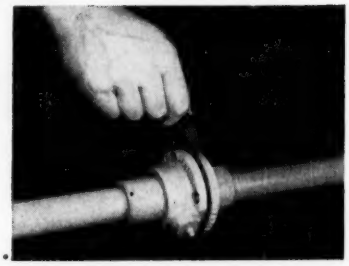


For the engineer concerned with flex or rotational problems, on lines handling steam, hot gas or chemicals, the new DS swivel joints present a quick, effective solution. Versatile packing design permits use of either disc or molded types of packing to meet a wide number of services. Split segments allow replacement of packings within minutes and without removing joint from the line. And within the eight basic configurations of the new DS series joint are models to provide full 360° rotation in one, two or three planes. DS series swivel joints are recommended for chemical services ranging from −40° to +400°F and 300 psi. In steam rotation, the maximum is 440°F at 360 psi. For complete details on this remarkable series of Chiksan swivel joints, write today for your copy of Bulletin 1258.



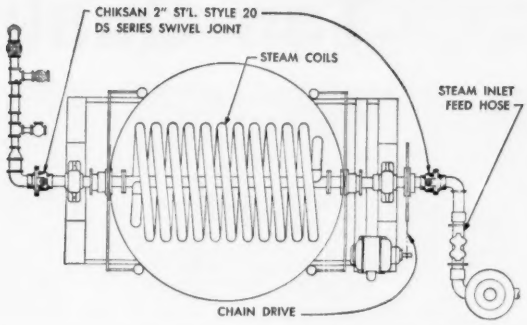
Sectional View showing typical molded packing installed

NEW *CHIKSAN* DS



REPLACE SEALS WITH SWIVEL JOINT IN LINE

Allen-type screws secure the two sections of the DS series swivel joint. Screws are readily removed and seals replaced with joint in the line.

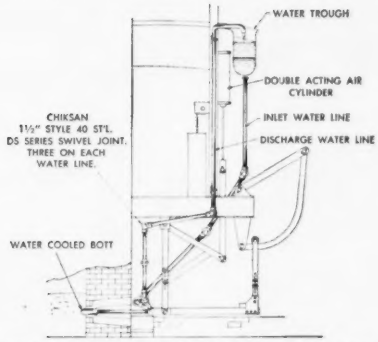


ROTATING STEAM COIL IMPROVES COOKING QUALITY, CUTS COSTS

For more details, request application report .009

Stationary steam coils in a large food processing plant were accumulating burned scale, reducing heat transfer by as much as 20% in a relatively short time.

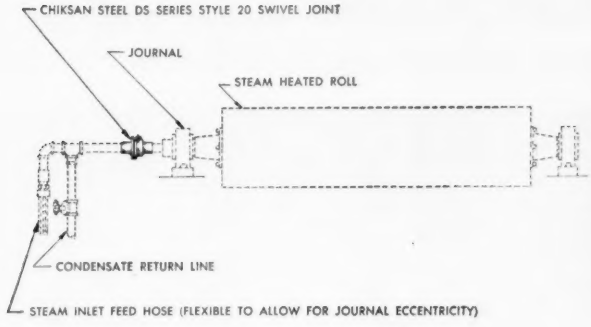
Using Chiksan DS series swivel joints, the plant engineer designed a self-scouring rotating coil. Net results, this plant now gets closer flavor and quality control—also sustains heat-exchange efficiency—thus saving fuel.



SWIVEL JOINTS HELP PULL THE PLUG ON MOLTEN SLAG

For more details, request application report .014

Pulling the water cooled bott permits removal of molten slag from blast furnaces. Proximity to the intense heat made rubber hoses out of the question. And even ordinary swivel joints weren't faring too well because packings would bake out in a day or two. New Chiksan DS series swivel joints deliver the solution, providing ten to twelve weeks of service before packing replacement is required.


CHIKSAN STEEL DS SERIES STYLE 20 SWIVEL JOINT
JOURNAL
STEAM HEATED ROLL
CONDENSATE RETURN LINE
STEAM INLET FEED HOSE (FLEXIBLE TO ALLOW FOR JOURNAL ECCENTRICITY)

STEAM STAYS ON THE BEAM WITH CHIKSAN SWIVEL JOINTS

For more details, request application report .004

To emboss plastic sheets, the material must be heated to a just-right degree of softness. A steam leak at the swivel joint connecting the stationary steam pipe to the revolving inlet means serious trouble. Previous tried devices were unsatisfactory. A DS series swivel joint was recommended. Present joint has been in service for better than four months with superior results. And when packing fatigue does occur, it can be quickly replaced with a minimum down time.

SWIVEL JOINTS

SERIES

CHIKSAN COMPANY, 330 North Pomona Avenue, Brea, California
Please send me copy of Bulletin 1258.
Please send me product application report .004 ☐ .009 ☐ .014 ☐

Name_____

Company_____ Title_____

Address_____

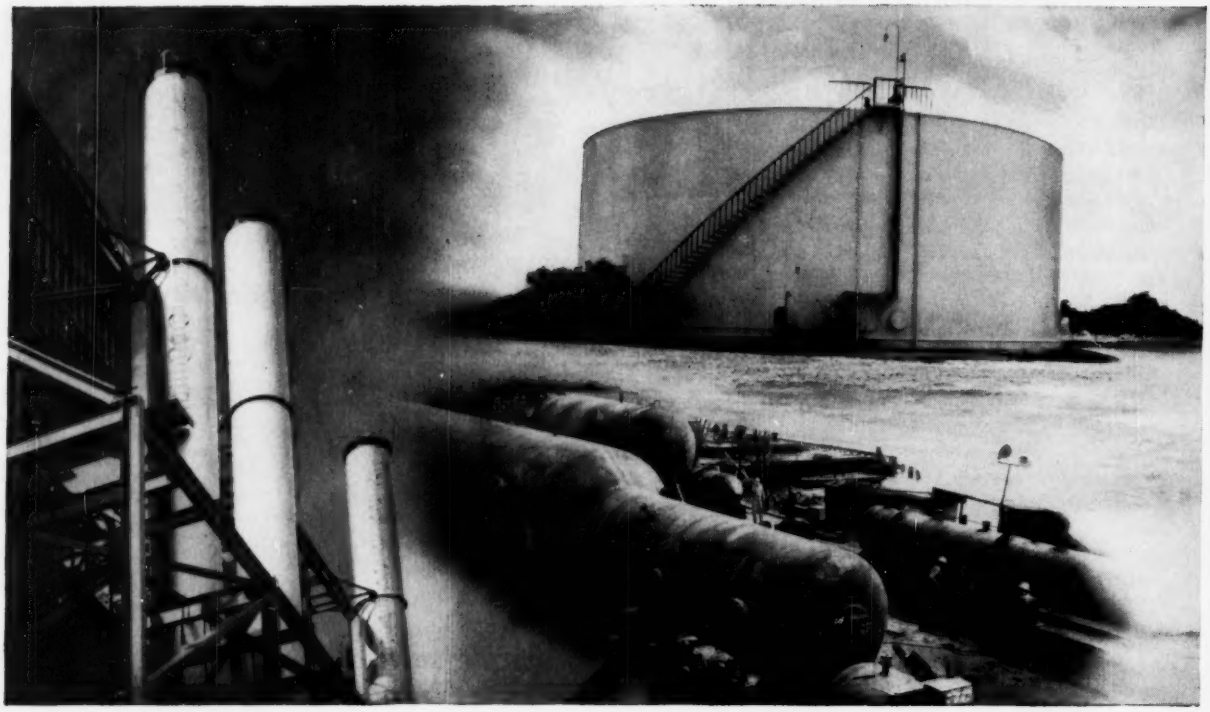
City_____ Zone_____ State_____

CHIKSAN fmc

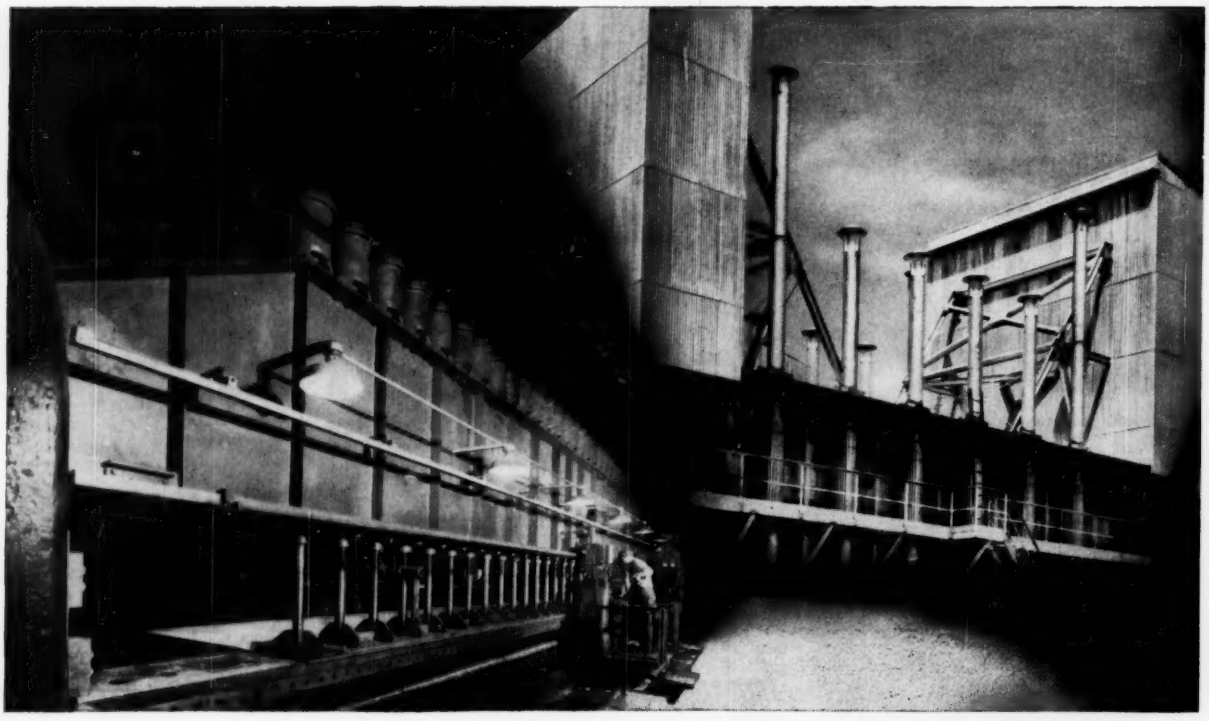
A SUBSIDIARY OF FOOD MACHINERY AND CHEMICAL CORPORATION

CHIKSAN COMPANY—Brea, Calif. • Chicago 5, Ill. • Newark 2, N. J. • Weco (Division), Houston 1, Texas • Subsidiaries: Chiksan Export Co. • Chiksan of Canada Ltd.

Top-Quality

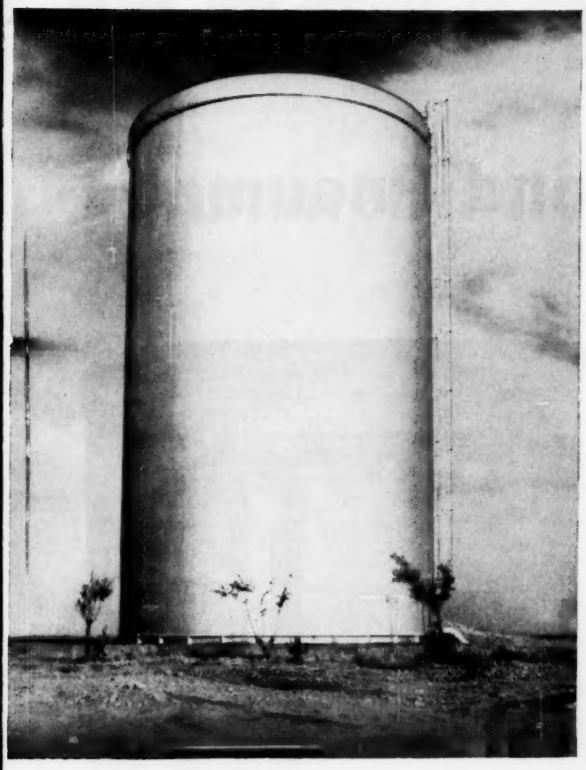


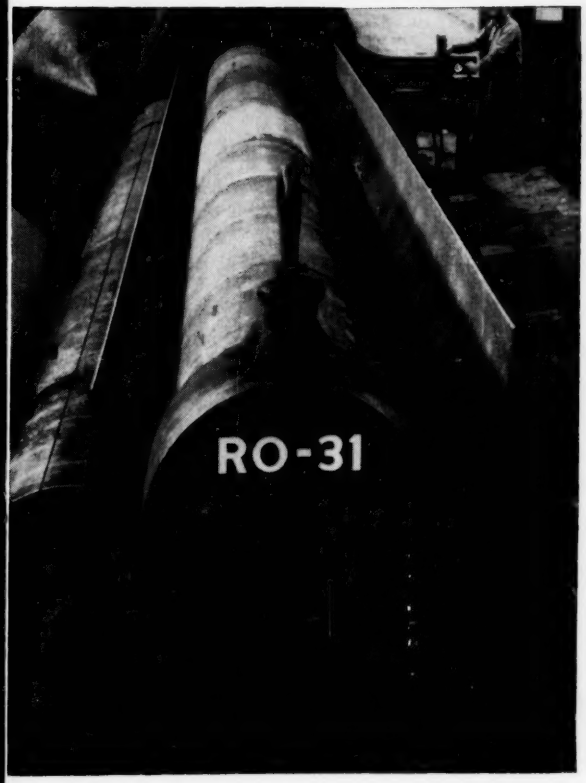
You name it, we'll make it; and erect it too!



Complete, modern fabricating facilities.

Plate Fabrication





by American Bridge

OUR completely modernized fabricating plant at Orange, Texas, is now equipped to handle any type and size of custom plate work—from stacks, pipe, bins and tanks to heavy-wall pressure vessels.

And, because of its strategic location on water, rail, and truck routes, you can count on fast delivery and low shipping costs.

We are equipped to handle your plate work from start to finish—from fabrication to erection—efficiently and economically. We are also prepared to quote on any individual part of your plate requirements.

Modern facilities to handle important jobs. Our large, two-aisle building has seven cranes capable of lifting, in combined use, over 100 tons; large car bottom-heating and stress-relieving furnaces; heavy plate bending rolls; a variety of presses and press brakes; the latest in welding and X-raying equipment, plate shears, edge planers, boring mills and drills.

For top-quality plate work, get in touch with the nearest office. Or, write for our new booklet which completely describes the facilities and services available from our Orange plant.

USS is a registered trademark

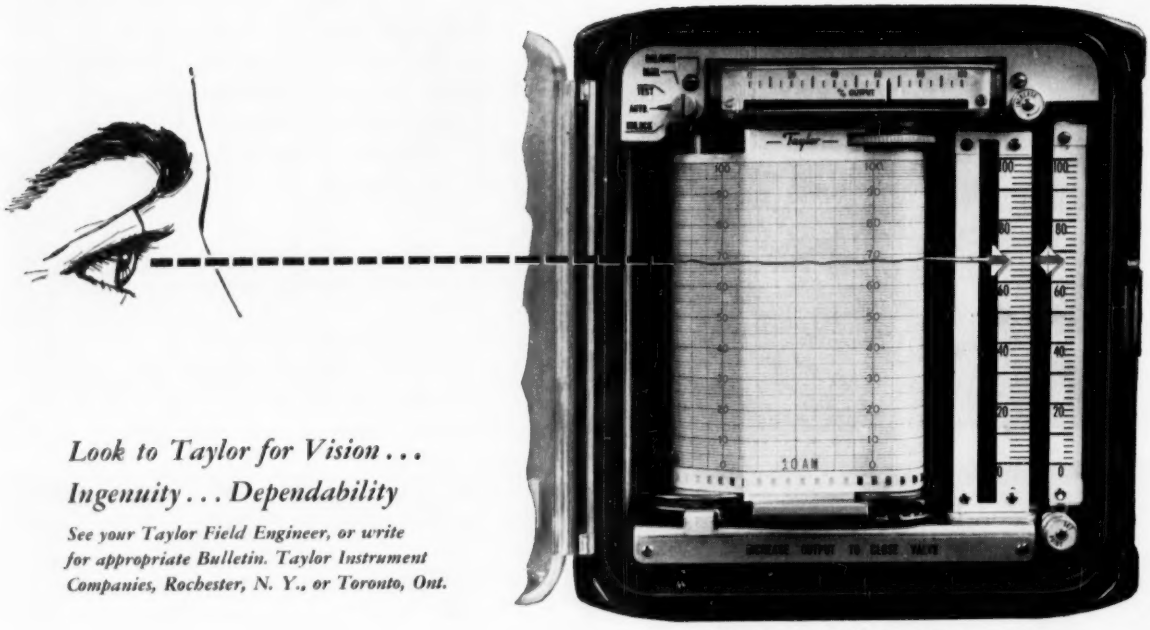
American Bridge Division of United States Steel

USS

General Offices: 525 William Penn Place, Pittsburgh, Pa.
Contracting Offices: Ambridge · Atlanta · Baltimore
Birmingham · Boston · Chicago · Cincinnati · Cleveland
Dallas · Denver · Detroit · Elmira · Gary · Harrisburg, Pa. · Houston · Los Angeles · Memphis · Minneapolis
New York · Orange, Texas · Philadelphia · Pittsburgh
Portland, Ore. · Roanoke · St. Louis · San Francisco
Trenton · United States Steel Export Company, New York

UNCONFUSED

in both Electronic and Pneumatic

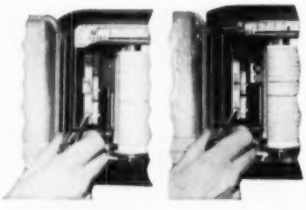


Look to Taylor for Vision . . .
Ingenuity . . . Dependability

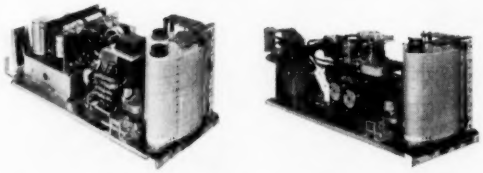
See your Taylor Field Engineer, or write for appropriate Bulletin. Taylor Instrument Companies, Rochester, N. Y., or Toronto, Ont.

701J AC or DC Electronic Recorder

Compare these features . . . common to the 701J Electronic



1. A Taylor 'first'. On both Electronic (left) and Pneumatic (right) instruments, controller response adjustments are quickly and easily made from the front, where results can be watched. You can visualize immediately all pertinent process information — chart, pen and set-point.



2. All major components plug in. Even individual amplifier circuits plug in. You can service all components and still stay on control. AC and DC Recorders are completely transistorized; unaffected by a supply voltage change up to ±10%.

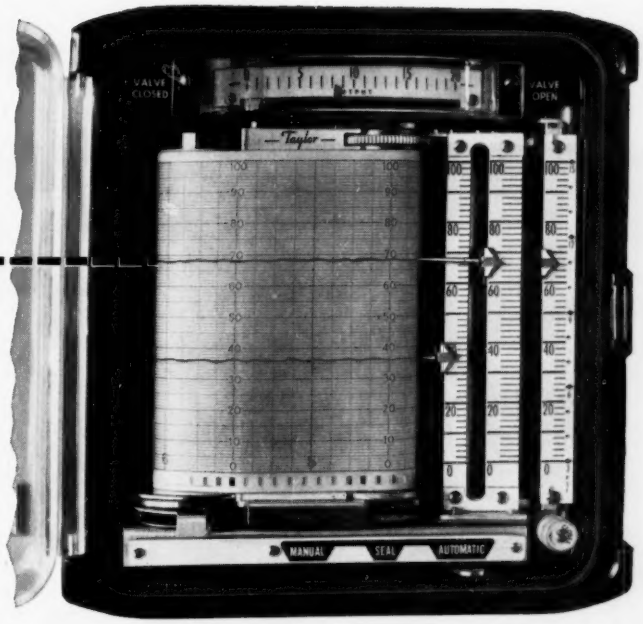
Taylor Instruments

READABILITY

instrumentation by Taylor

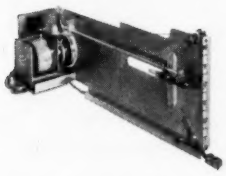
- **Simplest scanning of all** . . . because chart record, pen and set-point are side-by-side.
- **Invites frequent reading** . . . because target-type pens and pointers are easiest of all to see, even at a distance.
- **Operators make fewer mistakes** . . . because all pertinent data is lined up.
- **You read the 4″ chart** from left to right—like a newspaper—on rectilinear coordinates.
- **All these features** in a 6″ x 6″ cutout.

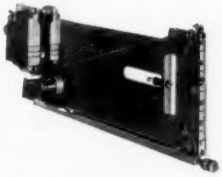
*Reg. U.S. Pat. Off.



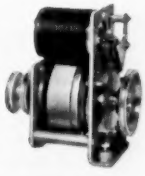
90J TRANSCOPE Pneumatic Recorder*

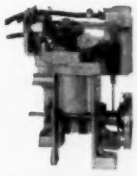
AC or DC Recorder and the 90J TRANSCOPE Pneumatic Recorder





3. Plug-in Set Point Transmitters, parallel to and exactly matching chart range, permit comparison without confusion and accurate adjustment of the control point. They can be removed for checking with only momentary interruption of record.

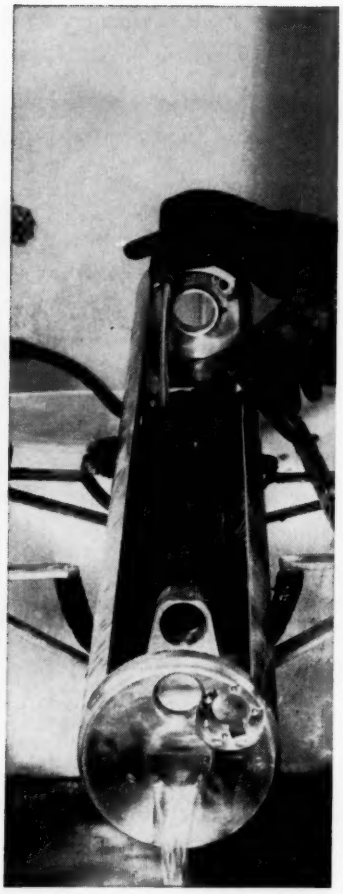




4. Powerful Servo Motors give more precise pen positioning than ever before. More accurate records. Unmatched threshold sensitivity. Unparalleled power permits use of process alarms, new inking system and elimination of flimsy linkage.

MEAN ACCURACY FIRST

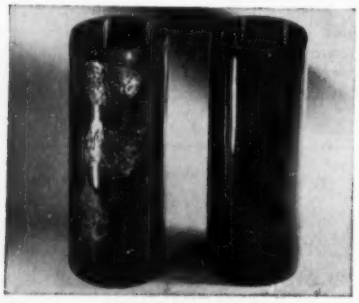
FLUI



FLUIDICS AT WORK

More thermal shock data on new Glasteel 59

We glassed the outside of two 2-inch steel pipes, one with Glasteel 59 (below right) and one with the best previous material, #53 Glass (left).



Then we heated both to 525°F. and quenched them quickly in a 70°F. bath. The picture at left shows what happened. Glasteel 59 shows not a bit of damage . . . in spite of a 455°F. instantaneous thermal shock.

In other tests we heated Glasteel 59 to 600°F. and gave it a 530°F. shock and then to 625°F. for a startling 555°F. shock. There still was no sign of cracking or crazing or other damage on the sample pipe.

Naturally we do not recommend such severe treatment for your equipment; but we do recommend Glasteel 59 as offering the greatest protection against thermal shock damage.

Circle "A" on the coupon for more information on this new material.

FLUIDICS AT WORK

Washing away radioactivity with ion exchange

Was a time when $30,000 control rod drive housings like this were buried because of radioactivity.

Now the contamination is scrubbed off and the parts are reclaimed with the help of a Permutit nuclear purifier. Each refill of 3 cu. ft. of ion exchange resin in this unit decontaminates thousands of gallons of rinse water.

For more information on this process and its other uses in nuclear work, circle "B" on the coupon.

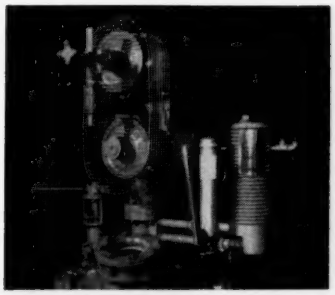
DICS

is a Pfaudler Permutit program providing the know-how the equipment and the experience for solving problems involving fluids.

FLUIDICS covers such varied phases of fluid handling and control as:

corrosioneering
water treatment
waste treatment
reactions
polymerization
ion exchange
fluid analysis
agitation
evaporation
distillation
drying
blending
metering
valving
flow rate control
piping
storing
centrifuging
filling
heat transfer, etc.

Whenever you have a fluid-handling problem, look to this Pfaudler Permutit FLUIDICS program for the best solution.



FLUIDICS AT WORK

New W Drive packs a lot of power at low cost

Fluid agitation is an important phase of the FLUIDICS program. Witness this compact, relatively inexpensive worm drive that carries up through 10 hp.

Its pedestal mount is easily adapted to any tank design, even open vessels. The drive usually carries a Glasteel impeller, so it's ideal for corrosive work. Alloy impellers and turbines are also available.

Maintenance on the W Drive consists almost entirely of routine lubrication and periodic alignment checks.

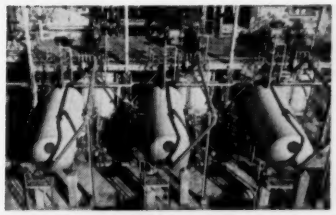
It takes either stuffing box or mechanical seal. Fixed speed or variable speed sheaves are standard. You can specify hydraulic, explosion-proof design.

For details, circle "C" on the coupon.

SPEED RANGE WITH VARIABLE SPEED SHEAVES

Drive Ratio	2.5W		3W	
	HP at Max. Speed	Agit. RPM Range	HP at Max. Speed	Agit. RPM Range
5:1	2	600 to 128	3	600 to 128
10:1	2	300 to 64	3	300 to 64
20:1	2	150 to 33	3	150 to 33
30:1	1.5	100 to 22	2	100 to 22

Note: There are 4W and 5W drives which deliver 7.5 and 10 HP respectively in comparable speed ranges.



FLUIDICS AT WORK

Phillips Petroleum uses Glasteel for processing natural gas liquids

$AlCl_3$ and HCl, highly corrosive catalysts used to process natural gas liquids, are kept in check at Phillips Petroleum with Glasteel . . . in reactors, tanks, and towers. Performance is so successful, Phillips is now building a second all-Glasteel plant. Circle "D" on coupon for the facts on the full line of Glasteel equipment.

PFAUDLER PERMUTIT INC. Pfaudler Div., Dept. CE-29, Rochester 3, N.Y.

Circle item wanted: A, B, C, D.

Name.....

Title.....

Company.....

Address.....

City.....Zone.....State.....

Foxboro Pneumatic Consotrol Control Panel at Hercules Powder Company, Burlington, N. J. This Foxboro panel is arranged in a 180° arc so operators can spot warning lights from any position. Continuous air purge in control room eliminates need for explosion-proof electrical switches, alarms, and signal lights.

Hercules Powder Company reports:

175 Pneumatic Consotrols* on stream three years *"—not a single unscheduled shutdown"*

At the Hercules plant in Burlington, New Jersey, they're producing millions of pounds of di-methyl teraphthalate a year. Foxboro Pneumatic Consotrol indicators, recorders and controllers provide the instrumentation for the entire multi-million dollar plant.

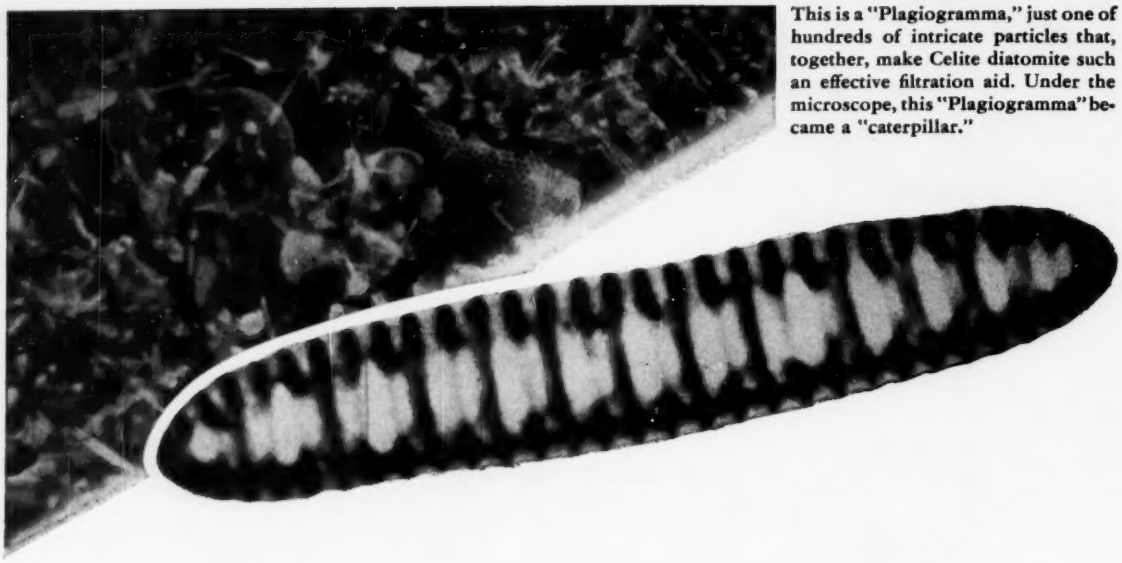
Hercules operators find their Consotrol instruments perfect for the job. They like the ± 1% accuracy of control they get. What's more, they're able to service an M/58 Consotrol Controller—even to a complete disassembly—and have it back in operation in just a few minutes. And they can convert a Consotrol indicator to a recorder by simply inserting a chart drive mechanism.

Get the full story on these low-maintenance, accurate Consotrol Recorder-Controllers before you design your next control system. Write for Bulletin 13-18—it has all the details. **The Foxboro Company, 362 Neponset Ave., Foxboro, Mass.**

*Reg. U.S. Pat. Off.

FOXBORO
REG. U.S. PAT. OFF.

pneumatic Consotrol instrumentation



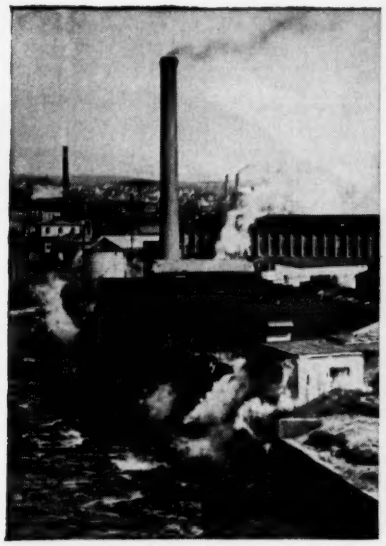
This is a "Plagiogramma," just one of hundreds of intricate particles that, together, make Celite diatomite such an effective filtration aid. Under the microscope, this "Plagiogramma" became a "caterpillar."

What's this "caterpillar" got to do with lower filtration costs?

It's a particle of CELITE that covers more

Assures highest purity in pharmaceuticals

Among the many important uses of Celite diatomite filter aids in industry today is the vital part they play in the production of life-saving antibiotics. Not only does Celite safeguard the purity of aureomycin, streptomycin and other pharmaceuticals; they also provide substantial cost savings that permit wider usage of these *wonder drugs.*



Protects communities from contaminated plant waste

Celite helps control pollution through removal of suspended solids from plant waste waters. Celite treatment often permits plants to reuse this water.

Provides greater clarity in varnish, lacquer and shellac

Celite filtration provides the high degree of clarity required in clear finishes. Celite is also widely used by the paint industry as a flatting agent and pigment extender.

Gives appetizing sparkle to syrups, jellies and other foods

Many food processors make an important *sales plus* of the outstanding brilliance that Celite provides. Celite also helps increase juice yields as a pressing aid.

-the diatomite filter aid filter surface per pound

THAT'S RIGHT. Celite* is the diatomite that gives you superior clarification at fast flow rates PLUS lower wet density. And lower wet density simply means greater surface coverage per pound of Celite. Which means substantial savings to you, for 6 bags of Celite will actually do the work of 7 bags of other diatomites.

And Celite is uniform. Every pound of it comes from Lompoc, California, the world's largest and purest diatomite deposit. Here, J-M technicians process and grade it so that no matter which convenient J-M warehouse you order from, the physical and chemical properties of each grade will never vary.

In addition, from Celite's full line of filter powders you can select the one grade that will give you the clarity you need at the highest flow rate.

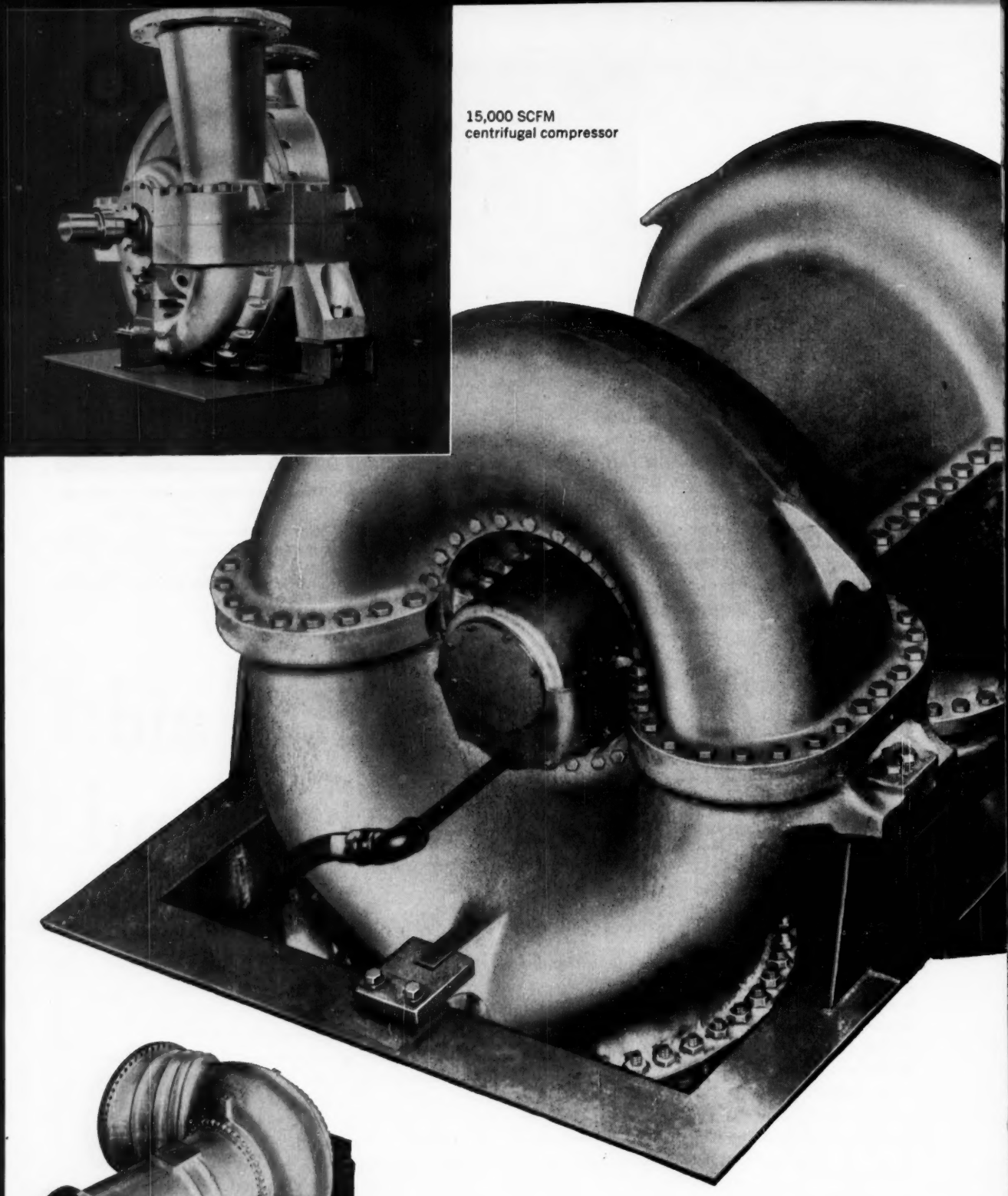
So if filtration belongs in your processing operations, it will pay you to call in your local J-M Celite engineer. Backed by Johns-Manville's research facilities and years of practical diatomite experience, he can help you with your filtration problems. Call him today or write Johns-Manville, Box **14,** New York 16, New York. In Canada, write 565 Lakeshore Road East, Port Credit, Ontario.

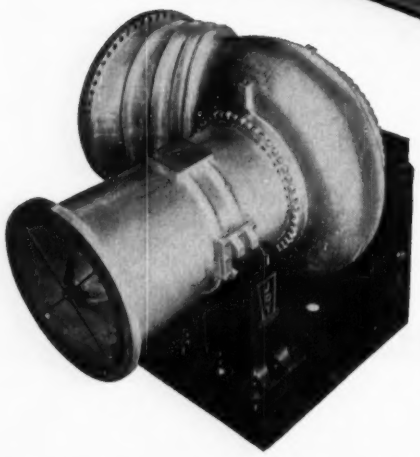
*Celite is Johns-Manville's registered trade mark for its diatomaceous silica products.

JOHNS-MANVILLE

JOHNS-MANVILLE JM PRODUCTS

15,000 SCFM
centrifugal compressor





104,000 SCFM, 6000 hp
axial compressor operating
with 1100° inlet temperatures
and 200 psia inlet pressure.

HIGHER

stage performance and efficiency in Joy axial and centrifugal compressors— what it means to you

125,000 SCFM,
15,000 hp, eight—stage
axial compressor

Lower Initial Costs
Higher performance per stage means fewer parts and lower manufacturing costs.

Lower Operating Costs
Higher stage efficiencies result in a higher over-all compressor efficiency, which means lower power requirements and reduced cooling water needs.

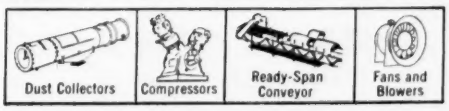
Smaller Size
Higher performance per stage means fewer stages and smaller over-all dimensions for the compressor cases. This results in a considerable saving of floor space and smaller headroom requirements.

Less Weight
Fewer stages and smaller cases mean a considerable saving of weight, with a reduction in foundations, column size, floor loading factor, and vibration.

Increased Reliability
Fewer stages mean fewer inter-stage seals, shorter and more rigid rotors, lower bearing loads and reduced differential expansion of cases and rotors. Write for full details on how the advanced Joy axial and centrifugal designs can save you money on your compressed air requirements. Ask for Bulletin 277-11

WSW I 7400-277

AIR MOVING EQUIPMENT FOR ALL INDUSTRY



JOY

Joy Manufacturing Company
Oliver Building, Pittsburgh 22, Pa.

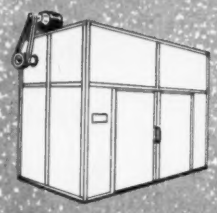
In Canada: Joy Manufacturing Company (Canada) Limited, Galt, Ontario

WHAT'S BEHIND THE PLUS PERFORMANCE OF

PROCTOR DRYING EQUIPMENT?

Continuous Research - Applied to Product Improvement

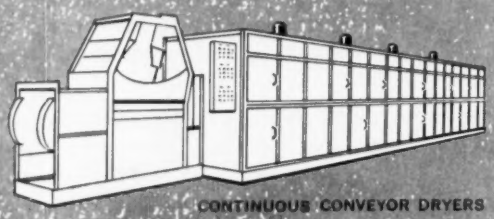
A most important requirement in dryer performance is uniformity of air circulation. Our research has resulted in a single conveyor dryer basic design which assures uniformity of air circulation, utilizing the finest air system available in commercial dryers today.



TRUCK DRYERS

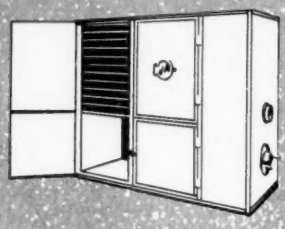
The Proctor Diamond Jubilee Design Single Conveyor Dryer assures you of top drying performance because uniformity of air circulation controls the resultant uniformity of your product quality.

When you have a drying problem—call on a Proctor engineer to explain all the details of this *plus performance.*



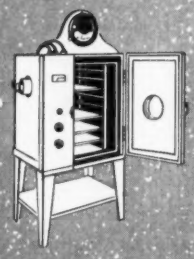
CONTINUOUS CONVEYOR DRYERS

TRAY DRYERS



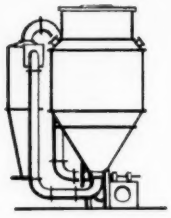
THIS NEWEST DESIGN FEATURES...

- **The Air Form Scroll designed specifically for dryer work**
- **Air Volume Control without disturbing air flow**
- **Uniform Air Distribution over the full conveyor width**



LABORATORY DRYERS

Pilot Plant and Semi-works Spray Dryer quickly adapts to handle a broad range of products as shown in bulletin #431. Production models available to meet your product and output requirements.



Proctor®

PROCTOR & SCHWARTZ, INC.

PHILADELPHIA 20, PA.

New motor development obsoletes today's application practices!

Only from Allis-Chalmers!

Super-Seal motors save up to 60%

Here's an amazing advance in motor technology! It's the *Super-Seal* motor line—an open motor design so completely unaffected by moisture, dust, dirt, oil, acids and alkalies that it can be used in many applications previously requiring more costly enclosed motors. *Savings range from 15 to 60%.*

Super-Seal motor superiority results from two distinct revolutionary insulating techniques. Available in any integral horsepower size, smaller *Super-Seal* motors incorporate a *Poxeal* stator. A durable epoxy resin encloses the stator, creating an electrical system impervious to outside elements.

In larger sizes, *Silco-Flex* insulation is used. In this system, silicone rubber is vulcanized into a homogeneous mass to form a flexible, moisture and heat resistant, void-free dielectric barrier around coils and leads.

Both of these insulation systems are unsurpassed. Proof? An encapsulated motor ran for hundreds of hours at full load in a 4% brine solution.

Find out more by reading the next pages; then contact your A-C representative or distributor, or write Allis-Chalmers at address shown on back page.

ALLIS-CHALMERS

51B 9100

Two revolutionary insulating techniques developed and pioneered by Allis-Chalmers mean savings of millions of dollars for motor users . . .

New open motors are unaffected by moisture and contaminants

Modern insulating materials and new methods of application, now available in *Super-Seal* open-type motors, are drastically changing motor application standards. These insulations are so completely impervious to moisture and contaminants that *Super-Seal* open motors can be used in most applications formerly requiring costly enclosed designs. Existing applications have resulted in savings as high as 60%.

Basic insulation systems

Larger *Super-Seal* motors with form-wound stator coils use the *Silco-Flex* insulation system. Heart of this system is a remarkable rubber-like silicone elastomer, applied in semi-cured state and vulcanized to form a void-free, impervious dielectric barrier. More than four years of development and field testing have proven the superior electrical and physical properties of *Silco-Flex* insulation systems.

Stator coils of smaller random-wound motors are protected by equally effective *Poxeal* insulation system. A tough, durable case of epoxy resin completely seals the winding end turns and slot portions. Bonded to the stator laminations, it forms a seal completely impervious to contaminants.

Moisture resistance

In addition to being void-free, the silicone elastomer used in *Silco-Flex* insulation is moisture repellent. Even in high humidity, moisture does not form a surface film of condensation. Coils with this protection can operate completely immersed in water. In fact, one of the recommended cleaning procedures is use of detergent and water.

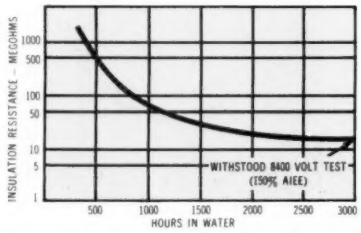


Fig. 1—Test curve shows insulation resistance of *Silco-Flex* insulation while immersed in water.

Moisture resistance of *Silco-Flex* coils is demonstrated in Fig. 1. After more than 3000 hours of total immersion with 2300 volts impressed on the coil, the test was terminated when it became apparent that little more drop could be expected in the coil's insulation resistance. At that point the coil still withstood a high potential test of 8400 volts without injury.

Encapsulated stator windings are equally well sealed. Motors with *Poxeal* insulation protection have been thoroughly tested under water while operating with full load and full voltage.

Resistance to contaminants

Silicone elastomers and epoxy resins are relatively inert to attack by practically all reactive agents. Further, the void-free construction of insulation systems used in *Super-Seal* motors prevents penetration of contaminants. As a result, *Super-Seal* motors are unaffected by oils, most acids, salt solutions, alkalies, and oils and are ideally suited for such applications.

Thermal stability

Temperature-wise, *Silco-Flex* insulation can easily withstand hot-spot temperatures of 200 C and more—

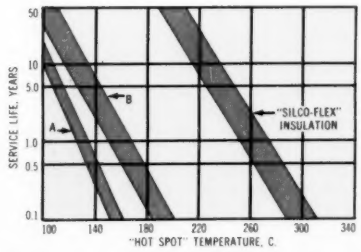


Fig. 2—Chart shows that *Silco-Flex* insulation more than meets Class H requirements.

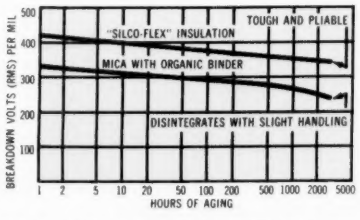
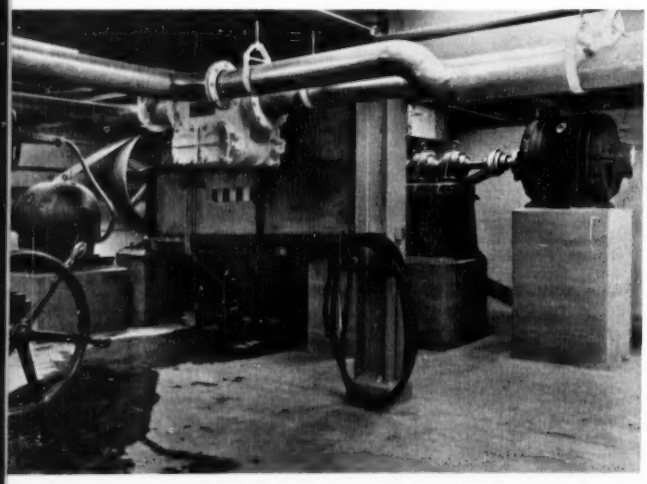


Fig. 3—Tests of 2300-volt insulated bars show thermal stability of *Silco-Flex* insulation.



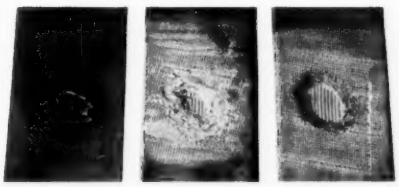
Paper mills have wide application for *Super-Seal* motors because of moist atmospheres.

easily meeting Class H temperature requirements (Fig. 2). At temperatures where the life of Class B coils would be measured in weeks, the life span of *Silco-Flex* coils is well beyond machine obsolescence.

Comparison with a mica-organic binder insulating system (Fig. 3) offers further proof of thermal stability. After 2000 hours of aging at 200 C with 8500 volts applied continuously, the *Silco-Flex* insulated coil was still tough, pliable, and completely serviceable. The mica-taped insulation had deteriorated to the point where it disintegrated readily and was completely useless.

An added advantage of *Silco-Flex* insulation is unusually high thermal conductivity — about twice that of conventional insulations. This means heat dissipates faster from its point of generation.

Poxeal insulation also demonstrates remarkably good thermal stability. Materials now in use are suitable for Class B temperatures, although actual classification of the insulation is determined by the basic material used.



Silco-Flex Insulation | **Polyester Mica Tape** | **Asphaltum Mica Tape**

Fig. 4—Samples of motor insulations after sandblasting give comparison of abrasion resistance.

Abrasion resistance

Resistance to abrasion is still another point of superiority in the insulation systems used for *Super-Seal* motors. Abrasion resistance of *Silco-Flex* insulation is compared to other types of insulation in Fig. 4. After one minute of sandblasting with 90-grit aluminum oxide and 100-psi air, only slight surface erosion appeared on the *Silco-Flex* sample. Other insulations were eroded to bare copper.

Application practices obsolete

The superior qualities of *Super-Seal* insulating systems, developed by Allis-Chalmers, make it necessary to reappraise present application practices. With virtually ageless insulation, *Super-Seal* motors assure more reliable service and require less upkeep than the best protected, conventionally insulated machines — and at considerably less cost.

Super-Seal, Poxeal, and Silco-Flex are Allis-Chalmers trademarks.

CHRYSLER KIMBERLY-CLARK GOODYEAR SOUTHERN CEMENT CONTINENTAL CAN SCOTT PAPER AMERICAN OIL CELOTEX FORD HURON PORTLAND CEMENT FIRESTONE PACIFIC GAS & ELECTRIC STANDARD OIL OF INDIANA B. F. GOODRICH DOW CHEMICAL MARLEY INGERSOLL-RAND LINK-BELT

WIDE ACCEPTANCE

of Super-Seal motors proves their advantages

Cement, petroleum, chemical, steel, mining, paper, utilities, municipalities and general industry — outstanding corporations in every field are specifying *Super-Seal* motors wherever operating conditions are tough.

Cost and *superior insulation* aren't the only reasons. Users are getting MORE MOTOR, too. Here's why:

Standard totally-enclosed motors, 55° C rise, have a *service factor of 1.* In other words, "nameplate" horsepower is the maximum. A 40° C rise *Super-Seal* motor with *Poxeal* insulation, and a 60° C rise *Super-Seal* motor with *Silco-Flex* insulation have a *service factor of 1.15.* For comparisons on what this difference means in required motor sizes, see this chart:

Rated Horsepower (Maximum Hp, TEFC)	Maximum Continuous Hp—*Super-Seal* Motor
15 hp	17.25 hp
25	28.75
40	46
75	86.25
125	143.75
200	230
350	402.5
500	575

Join the swing to *Super-Seal* motors. It will pay dividends fast. Contact your A-C representative or distributor, or write Allis-Chalmers at address shown on back page.

ALLIS-CHALMERS

SOUTHERN CALIFORNIA EDISON LONG ISLAND LIGHTING AVCO UNION BAG UNIVERSAL ATLAS UNION CARBIDE OHIO OIL INTERNATIONAL PAPER SOUTHERN PACIFIC PIPE LINE ALCOA ROHM & HAAS ARMOUR SHELL OIL COMMONWEALTH EDISON OWENS-ILLINOIS WYANDOTTE CHEMICAL BETHLEHEM STEEL ALLEGHENY-LUDLUM MEAD DU PONT DETROIT EDISON ESSO HERCULES POWDER SINCLAIR PIPE LINE GENERAL TIRE MONSANTO

This *SUPER-SEAL* MOTOR application SAVED $3000!

Find out how much you can save

This application of a *Super-Seal* open-type motor — in place of a weather-protected design of the same rating — *saved the user $3000.00!*

You can achieve similar savings! Fill out the data sheet below and *find out for yourself how much you can save — on a "no-strings-attached" basis.*

Here's what to do: 1) Select an enclosed motor application in your operations (a new motor need or, for comparison, a motor just purchased); 2) fill out the data sheet; 3) mail to the address shown.

We'll give you a cost quotation on a *Super-Seal* open motor for that application.

Fill out this data sheet—

no strings attached—to find out how much you can save on a new motor or on an existing motor installation

To: **ALLIS-CHALMERS**
888 S. 70th St., Milwaukee 1, Wis.

Motor Data

1. Type (i.e., squirrel cage):

Horizontal ☐ Vertical ☐

Hp..... Rpm.....

2. Phase..... Frequency.....

Voltage.....

3. (For synchronous only)

Power factor.....

Starting torque.....

Pull-in torque.....

Pull-out torque.....

Application Data

4. Description of application:

5. Drive: Direct-connected ☐

V-Belt ☐ Other:.....

Starting load.....

Ambient temperature.....

6. Operating conditions:.....

Dirty ☐ Clean ☐ Wet ☐ Dry ☐

Other.....

Information on Existing Motors

(for comparison)

7. Type of insulation

Type of enclosure

Time rating.....

Temperature rise.....

Bearings:

Anti-friction ☐ Sleeve ☐

8. Special characteristics or construction:

NAME.....

TITLE.....

COMPANY.....

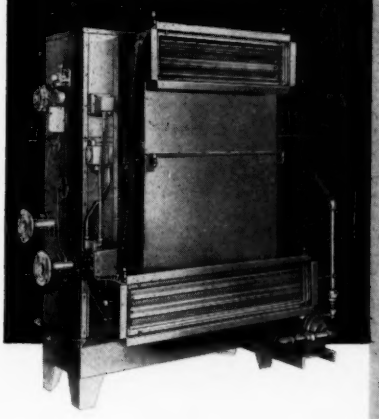
ADDRESS.....

A-5869

ALLIS-CHALMERS

NOW... *available in special corrosion-resistant* STAINLESS STEEL ALLOYS

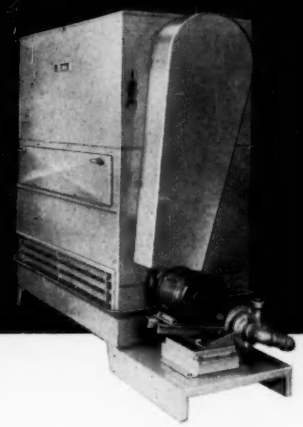
Marlo EVAPORATIVE TYPE CLOSED CIRCUIT COOLERS



To cool fluids, condense gases, dissipate waste heat.

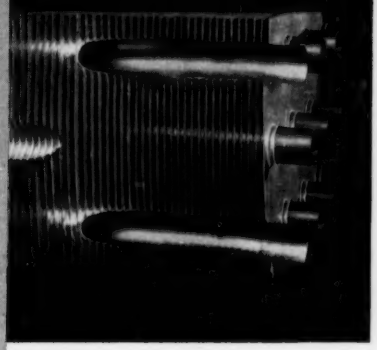
Modulating controls available.

Marlo COOLING TOWERS



Suitable for indoor or outdoor installation. Compact in design, quiet operating. All metal construction. Controls for winter operation.

Marlo FINNED HEAT TRANSFER SURFACES



To heat and cool fluids, condense gases, evaporate liquids. Also available in any combination of commercial metals and alloys.

for rugged, dependable process service...

FOR MORE INFORMATION SEND COUPON TODAY

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SAINT LOUIS 11, MISSOURI

MARLO COIL CO.
7100 S. Grand Blvd.
St. Louis 11, Mo.

Please send me information on Marlo equipment checked below:

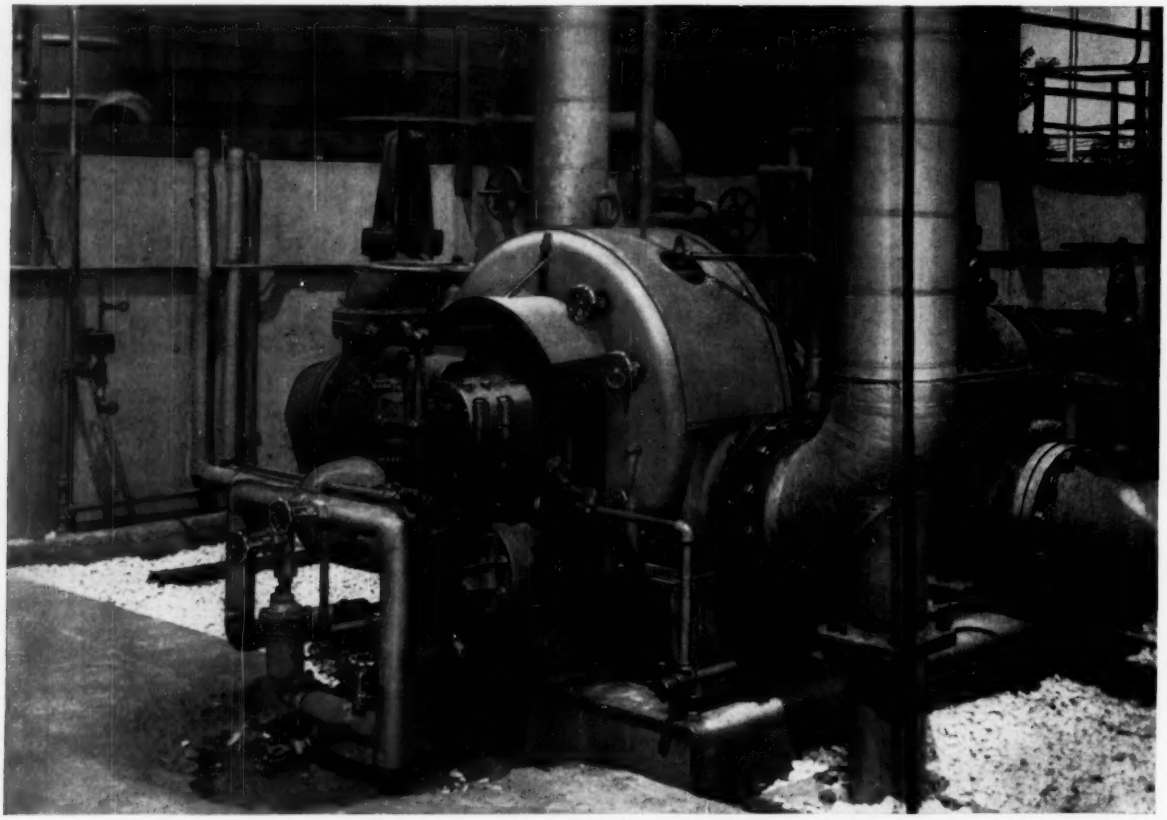
- ☐ Cooling Towers
- ☐ Evaporative Type Closed Circuit Coolers
- ☐ Finned Heat Transfer Surfaces
- ☐ Please have representative call

NAME_____

COMPANY_____

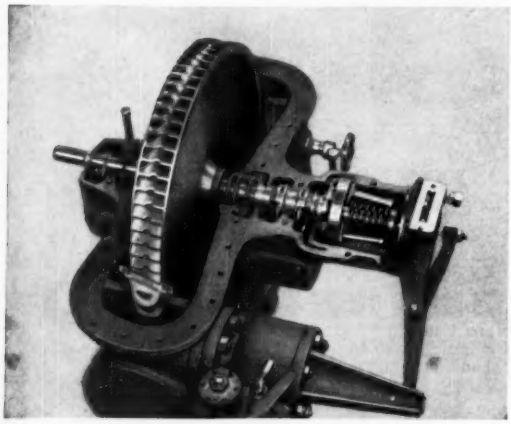
ADDRESS_____

CITY_____ ZONE___ STATE_____



TERRY SOLID-WHEEL TURBINES

used exclusively at Baton Rouge plant of W.R.Grace & Co.



The upper photograph shows one of the 17 Terry turbines installed at the Baton Rouge, La., GREX high-density polyethylene plant of W. R. Grace & Co. Above, a typical Terry solid-wheel turbine with cover removed to show the wheel construction.

In purchasing equipment for their new 50,000,000-pound high-density polyethylene plant, W. R. Grace & Co. standardized, wherever possible, on a single source of supply for each type of equipment used. Consistent with this policy, Terry steam turbines were used exclusively throughout the utility and process sections of the plant.

A total of 17 turbines were placed in service for driving pumps and fans. These are all of the solid-wheel type, ranging in capacity from 50 to 240 HP.

Terry solid-wheel turbines are known for their long life and sure dependability under the most-trying operating conditions. They feature a single-piece wheel which is virtually indestructible.

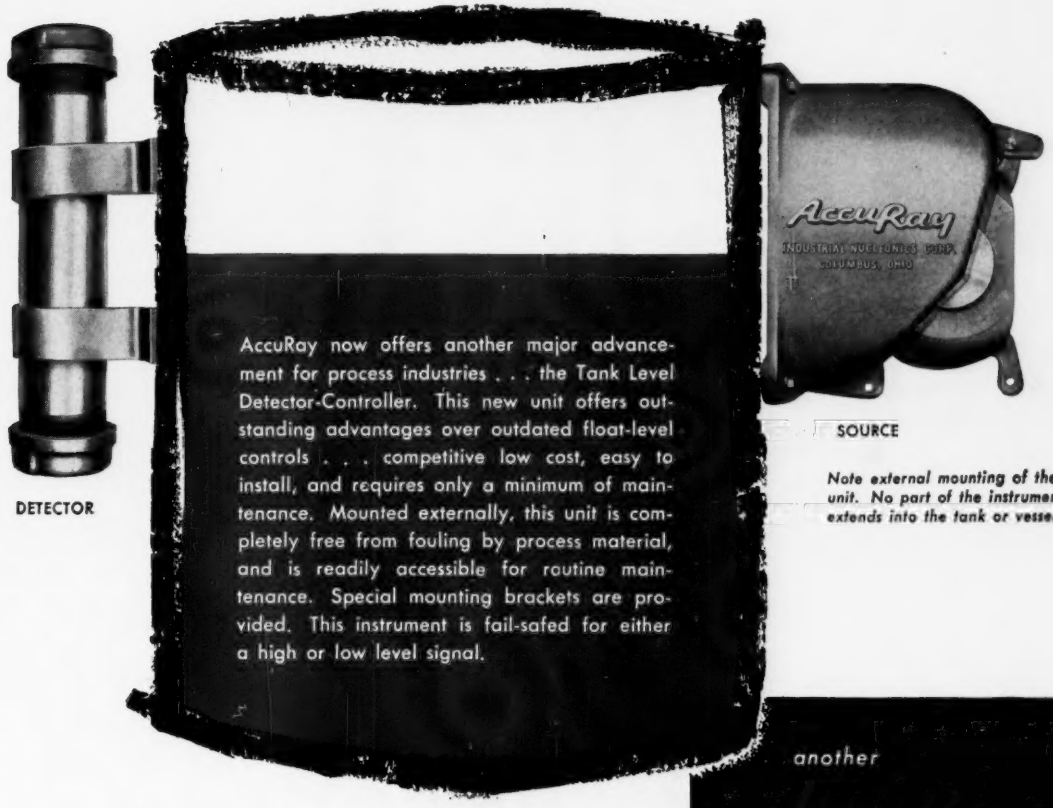
Send for details of these trouble-free turbines. Ask for a copy of bulletin S-116.

THE TERRY STEAM TURBINE COMPANY
TERRY SQUARE, HARTFORD 1, CONN.

TERRY

TT-1214

AccuRay TANK LEVEL DETECTOR-CONTROLLER



DETECTOR

SOURCE

Note external mounting of the unit. No part of the instrument extends into the tank or vessel.

AccuRay now offers another major advancement for process industries . . . the Tank Level Detector-Controller. This new unit offers outstanding advantages over outdated float-level controls . . . competitive low cost, easy to install, and requires only a minimum of maintenance. Mounted externally, this unit is completely free from fouling by process material, and is readily accessible for routine maintenance. Special mounting brackets are provided. This instrument is fail-safed for either a high or low level signal.

another

advancement for process control

The AccuRay Tank Level Detector-Controller can be used in two ways. It can be installed horizontally to provide a relay closure signal when the level rises above or falls below the level of the detector; or it can be installed vertically so that both a high level and a low level signal can be provided from one instrument. Accuracies can be maintained to plus or minus 1/16". The radiation source is installed either opposite the detector on the tank, or across a chord of the tank. The design of the source housing provides more than adequate shielding. Design of the instrument is in accordance with accepted standards for both explosion-proof and weatherproof operation.

® AccuRay is a Registered Trademark of Industrial Nucleonics Corporation

Industrial Nucleonics
CORPORATION
1149 Chesapeake Ave., Columbus 12, Ohio

Please send complete details on AccuRay Tank Level Detector-Controllers.

Name ..... Title .....

Company .....

Street .....

City ..... Zone ..... State .....

Application .....

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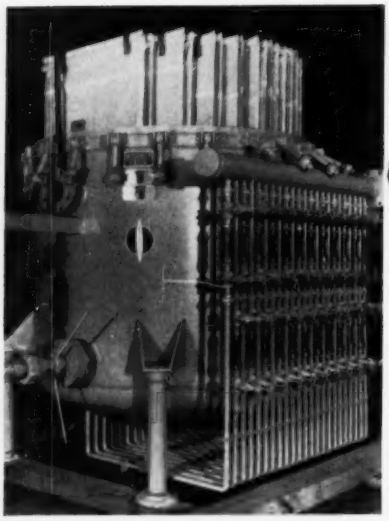
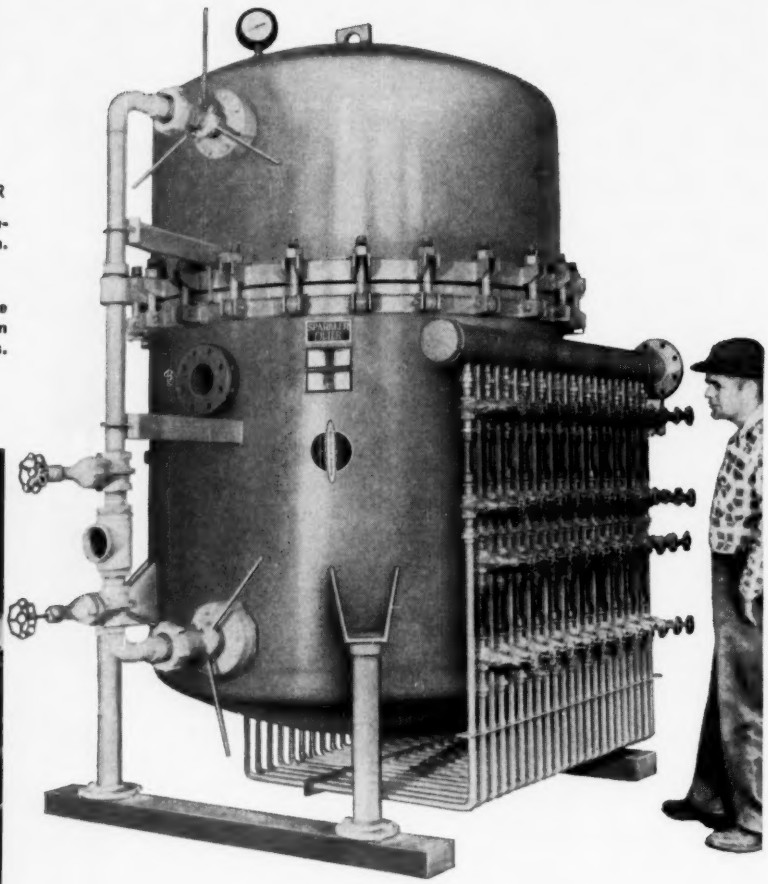
The WORLD'S LARGEST Manufacturer of Nucleonic Industrial Process Control Systems

SPARKLER MODEL VF FILTER

All Monel metal filter elements designed for filtering caustic solution. 850 sq. ft. of filtering surface.

Custom engineered for performance in areas with restricted headroom and other plant space limitations.





Another SPARKLER VERTICAL PLATE FILTER

Designed for service in one of America's largest chemical plants

Individual plate outlet control valves, sight glasses and sample cocks. Any plate may be cut out of service without interrupting filtering cycle.

This filter is particularly suited for toxic and volatile products. Sealed tank is maintained throughout cleaning and filtering cycles. Available in capacities from 100 sq. ft. to 1000 sq. ft.

Exclusive new vertical plate design. Rigid and non-collapsible plates, with unrestricted high flow center construction.

Spent cake is easily removed without opening filter with the exclusive Sparkler spray sluicing system.

You can depend on Sparkler for the latest developments in modern filtration engineering.

SPARKLER FILTERS

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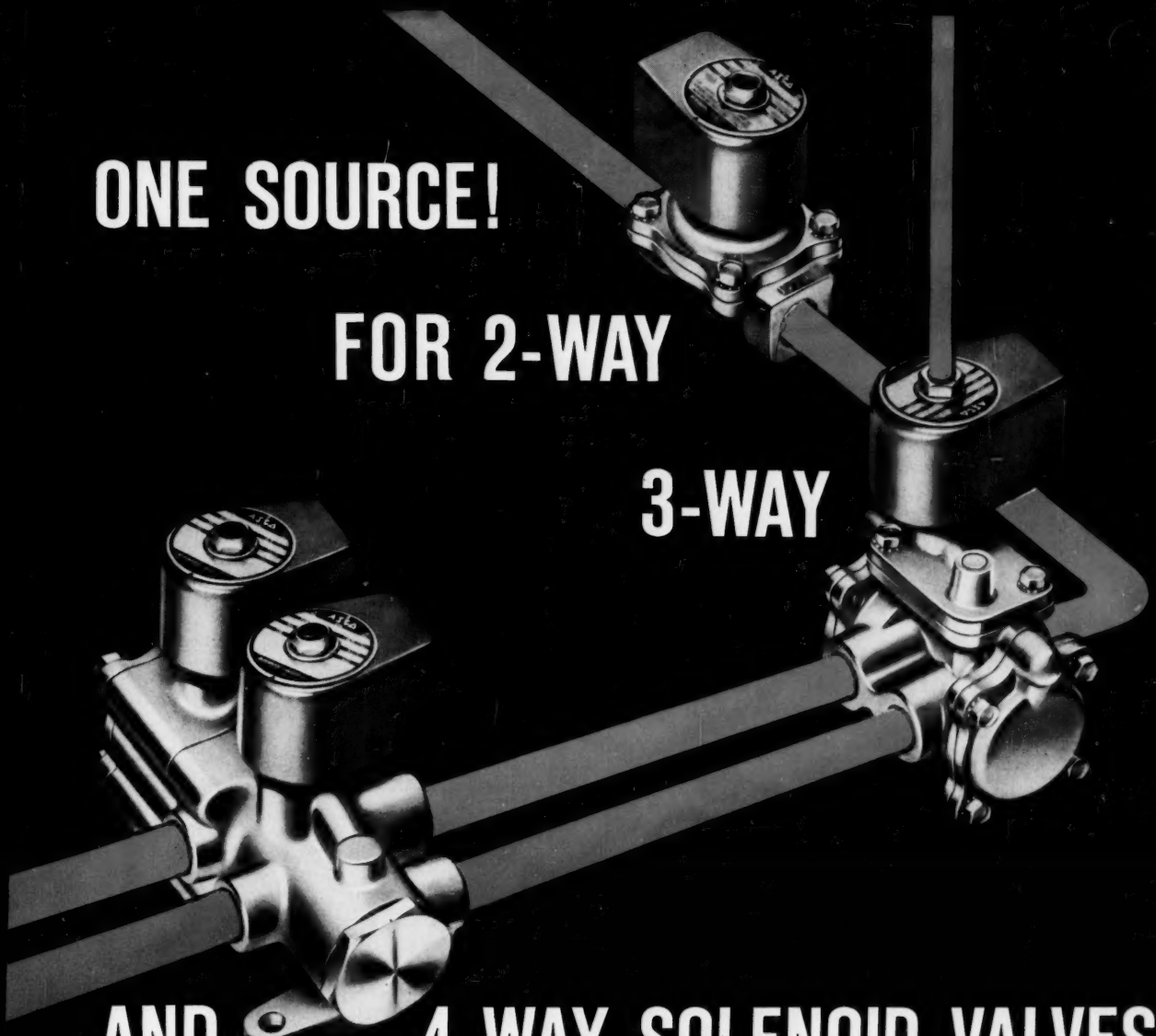
MUNDELEIN, ILLINOIS U. S. A.

Sparkler International Ltd., Manufacturing Plants at Leliegracht 9, Amsterdam, Holland; Toronto, Ontario, Canada; Italy and Australia.

FILTRATION ENGINEERING AND MANUFACTURING EXCLUSIVELY FOR OVER 30 YEARS.



ONE SOURCE! FOR 2-WAY 3-WAY AND 4-WAY SOLENOID VALVES

When you discuss solenoid valve requirements with an ASCO engineer, you benefit from the design and development experience of half a century. The ASCO specialist can recommend the right valve for your needs because ASCO pioneering has brought about the thousands of types of solenoid valves now available:

Two-way valves in pipe sizes from ⅛" to 8"—for temperatures from -350°F to 600°F—for pressures to 5000 p.s.i.

Three-way valves in pipe sizes from ⅛" to 2"—for temperatures from -350°F to 600°F—for pressures to 1000 p.s.i.

Four-way valves in pipe sizes from ¼" to 1½"—for temperatures from -65°F to 212°F—for pressures to 750 p.s.i.—poppet or slide type.

And ASCO can supply you with standard, explosion-proof or water tight enclosures—Class A and Class H coils—a wide range of body materials including cast iron, brass, bronze and stainless steel. Or trade on ASCO experience and have one of our engineers call.

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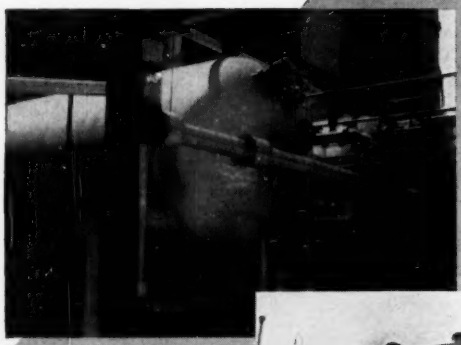
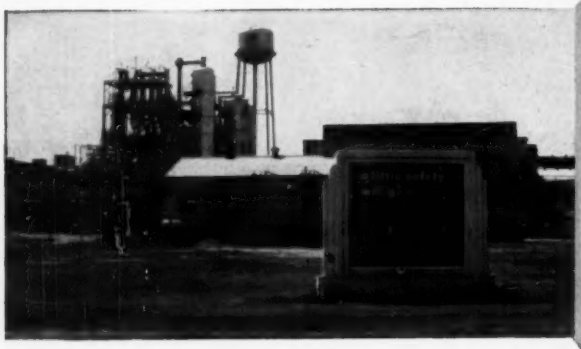
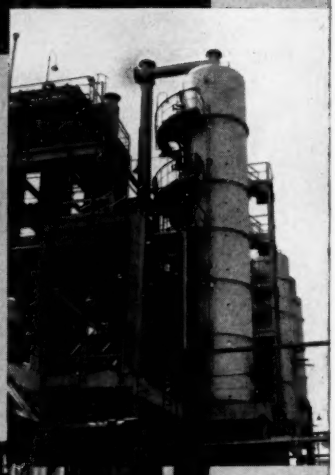
Yes, and for custom plate fabricated code tanks and pressure vessels, there's no substitute for experience. Modern Welding Company is proud to contribute to the progress of successful chemical processors.

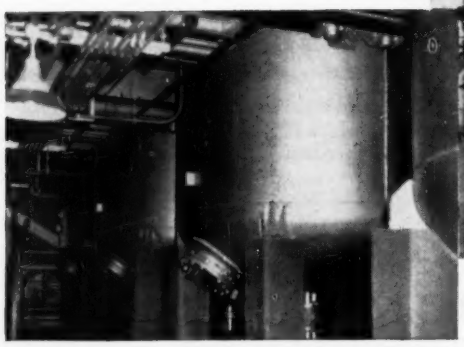


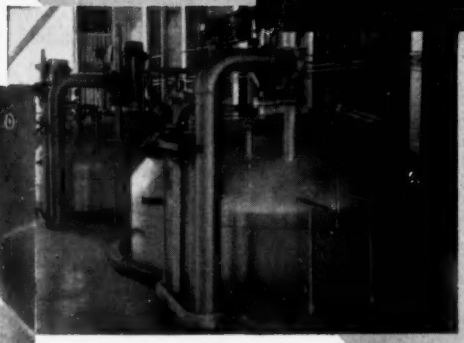
Horizontal Latex Blow-Down Vessel
11′ ID x 25′ TL, ¾″ heads, 11/16″ shell, 3 manholes, 14 nozzles, 2 sight glasses.



Styrene Stripping Column
10′ OD x 50′7″ TL, 11/16″ heads, ½″ shells, 14 internal stainless steel perforated trays, 16 manholes, 15 nozzles, 8 sight glasses.







Top and Bottom View, Vertical Latex Blown-Down Vessel
10′ OD x 9′6″ TL, 7/16″ heads, 9/16″ shells, 19 nozzles, 3 manholes, 85 WP with full vacuum.

ALL TANKS A. S. M. E. CONSTRUCTED

MODERN TANKS QUALITY

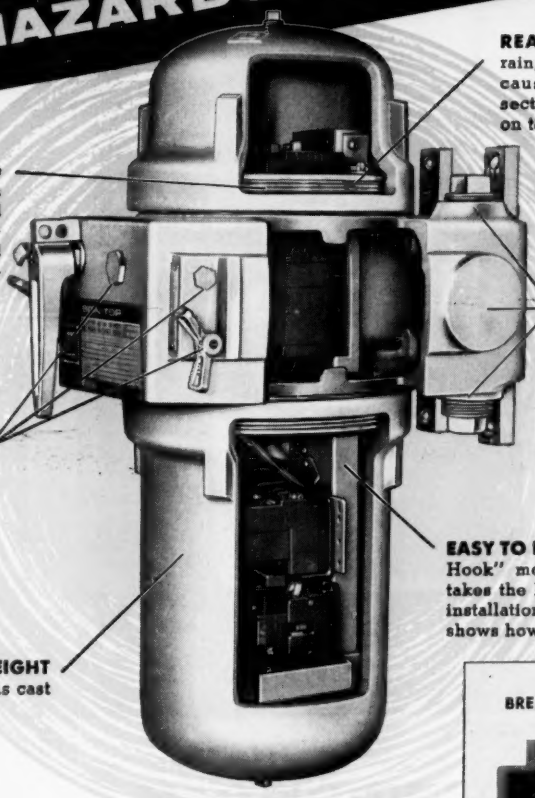
MODERN WELDING COMPANY
INCORPORATED
Owensboro, Kentucky
NEWARK, OHIO • ORLANDO, FLA. • HOUSTON, TEXAS • BURLINGTON, IOWA

Square D announces...

NEW SPIN TOP ENCLOSURE FOR HAZARDOUS LOCATIONS

REAL PROTECTION against rain, dust, dirt and weather because male threads on collar section engage female threads on tank.

DAMAGE-RESISTING Acme thread. If you've struggled with "banged-up" threads, you'll appreciate this feature. It's always a breeze to put on and take off tanks for installation, inspection or maintenance.

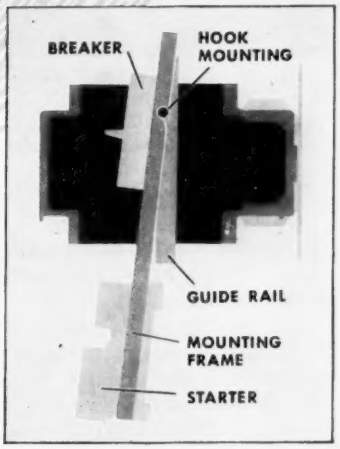


INCREASED WIRING SPACE and through-feed conduit entrances for horizontal tap-offs.

EASY TO ADD pushbuttons or selector switches with easy-to-buy, easy-to-use "off-the-shelf" parts kits.

EASY TO INSTALL • "Slide and Hook" mounting arrangement takes the hard work out of the installation job. Diagram below shows how.

STRONG and LIGHTWEIGHT The complete enclosure is cast aluminum.



SLIDE and HOOK MOUNTING

4 SIZES FOR STARTERS SIZE 0 THROUGH 5

CLASS I, GROUP C and D • CLASS II, GROUP E, F, and G

The new **SPIN TOP** enclosure is available from your Square D Distributor in three ways—complete device, enclosure only, or components only...for reversing and non-reversing across-the-line starters and combination starters. And for combination and non-combination two-speed starters.

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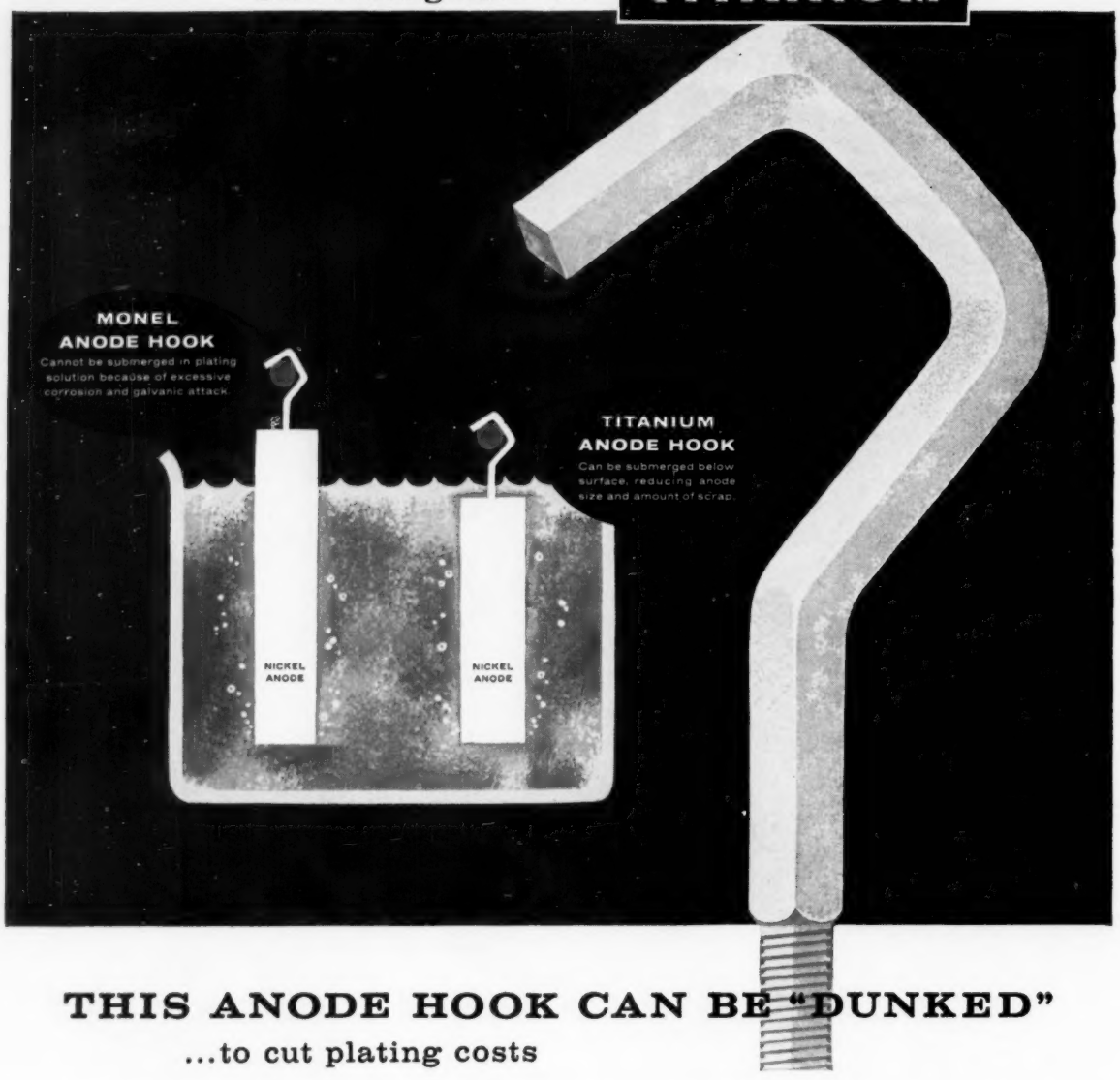
SQUARE D COMPANY

Cost cutting ideas in **TITANIUM**


MONEL
ANODE HOOK
Cannot be submerged in plating solution because of excessive corrosion and galvanic attack.
TITANIUM
ANODE HOOK
Can be submerged below surface, reducing anode size and amount of scrap.
NICKEL ANODE
NICKEL ANODE

THIS ANODE HOOK CAN BE "DUNKED"

...to cut plating costs

IF YOU'RE PLATING PARTS with nickel, chromium or copper, here's a cost-cutting idea worth investigating.

The titanium anode hook illustrated above offers important advantages in highly corrosive plating applications. For example, because of titanium's extreme resistance to corrosion, the bare hook can be "dunked" in nickel plating solutions. This means you use up practically *all* of the anode—reducing costly scrap waste. In addition, the titanium hook lasts indefinitely.

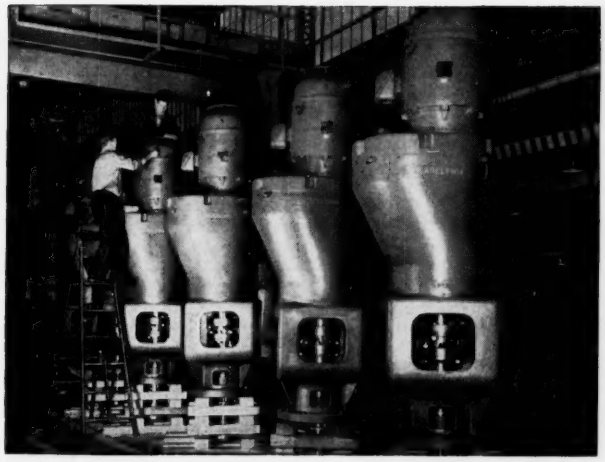
Titanium hooks, anode baskets and heating coils are now cutting costs in a number of large-scale plating applications... examples of how Mallory-Sharon's development work in titanium is paying off for industry.

Write for Technical Data Sheet and application information on titanium anode hooks, or any other high-corrosion problems you may have. Please address: Commercial Market Development, Dept. A, Mallory-Sharon Metals Corp., Niles, Ohio.

MALLORY SHARON

MALLORY-SHARON METALS CORPORATION • NILES, OHIO

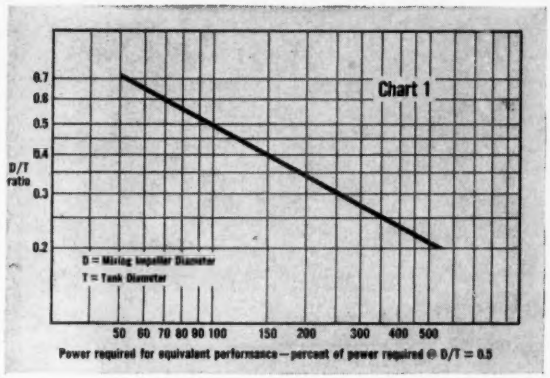
Integrated producer of Titanium • Zirconium • Special Metals



Q. In larger mixing operations, what are the economics of buying mixers that match requirements *exactly* compared to buying mixers having an adequate margin of torque capacity?

A. As mixing operations are scaled up and fluid mixers required increase in size, the cost per unit drive torque capacity decreases rapidly with the increase in drive size. It becomes poor economy not to maintain an adequate level of torque applied to the mixing operation. Consider also that agitators and auxiliaries rarely represent more than a small percentage (2-4%) of the plant investment . . . yet maintenance costs on the more difficult operations can run as high as 15% or 20%. If down time is considered, then costs can run many times these figures. Obviously, there is no economy in drives and components such as shafts which *just* meet requirements.

it's questions like these... that bring out the facts in buying mixers...



Q. Are "dollars per horsepower" a valid basis for comparing mixer values?

A. No. Mixers having the same horsepower rating and drive efficiency can vary widely in torque rating. Torque applied to the mix is what does the work and torque is what you pay for. When comparing mixer values, the most important first step is that of developing torque ratings of alternate units offered. Using the most familiar units, torque can be calculated as follows:

$$\text{Torque (lb. inches)} = \frac{63025 \times \text{Motor HP}}{\text{Mixer shaft RPM}}$$

The mixer having the lower torque rating must use a higher mixer shaft speed and smaller diameter impeller to maintain a given HP level. This can lead to unsatisfactory performance. However, a mixer of equivalent horsepower rating but with a higher torque rating and larger impeller will do the job well. For an idea of the importance of impeller size, the chart shows the influence of impeller diameter in relation to tank diameter (D/T ratio) upon motor required to obtain a specific level of performance in many industrial mixing operations. The bigger impeller at the slower speed (higher applied torque) will be a sounder choice.

YOU GET MORE FOR YOUR FLUID MIXER DOLLAR
Because We Design and Build The *Whole* Unit

It's simple economics! Philadelphia Mixer is the only manufacturer that designs and builds the complete unit. Because we control production and costs, we can afford to give you more mixer per dollar. For example:

- Extra large, heavy duty bearings throughout.
- Extremely heavy output shafting—machined, ground and polished.
- Drives designed with extra strength and rigidity to take maximum thrust and unbalanced loads.

You don't pay a premium for these extras—or for the better performance and longer life of a Philadelphia Mixer. You get them as a bonus.

You can select your Philadelphia Mixer from six standard models. 1 to 200 HP. Special units to 500 HP. Horizontal motor or vertical motor drive. Mechanical seal or packed stuffing box. Paddle or turbine type impellers.

Get the full story on Philadelphia Mixers. Write for Catalog A-27. It contains complete mechanical design information that permits you to make a catalog selection of the mixer that best suits your requirements.

PHILADELPHIA GEAR CORPORATION
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philadelphia mixers

Offices in all Principal Cities
INDUSTRIAL GEARS & SPEED REDUCERS • LIMITORQUE VALVE CONTROLS • FLUID MIXERS • FLEXIBLE COUPLINGS

SPROUT-WALDRON Pointers

for Mixing and Blending • Size Reduction
Size Classification • Bulk Materials Handling • Pelleting and Densifying

Published in the interest of better processing by Sprout, Waldron & Co., Inc., Muncy, Penna.

DUST OUT PROFITS IN

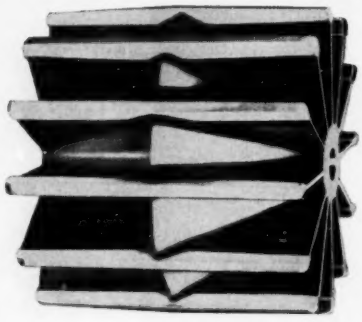
A threatened shutdown because of dust nuisance in the vicinity of his plant proved to be a godsend to a prominent Mid-West manufacturer. It led to his replacement of an inefficient pressure system Collector with an Adaptioneered® negative pressure Pneu-Vac. This brought results he never dreamed of. The dust nuisance was eliminated of course, but that was only the beginning.

His product that was going up in dust was recovered. Maintenance and power costs were reduced.

Because Pneu-Vac operates at negative pressure, dust leaks at joints are impossible, and because passing of material through the fan is avoided, it is applicable to friable materials where particle size reduction is undesirable.

Why not check your own dust problem to see if you are operating an inefficient system, losing valuable products, or suffering high maintenance and power costs. If you are, adaptioneered Pneu-Vac Systems are worth looking into.

SPROUT-WALDRON
PNEU-VAC
A negative pressure or vacuum air handling system, in which the fan is located on the opposite side of the collector from the material conveying line, so the product does not pass through the fan.



Stretch Your Conveyor Dollars With Sprout-Waldron Belt Saver® Pulleys

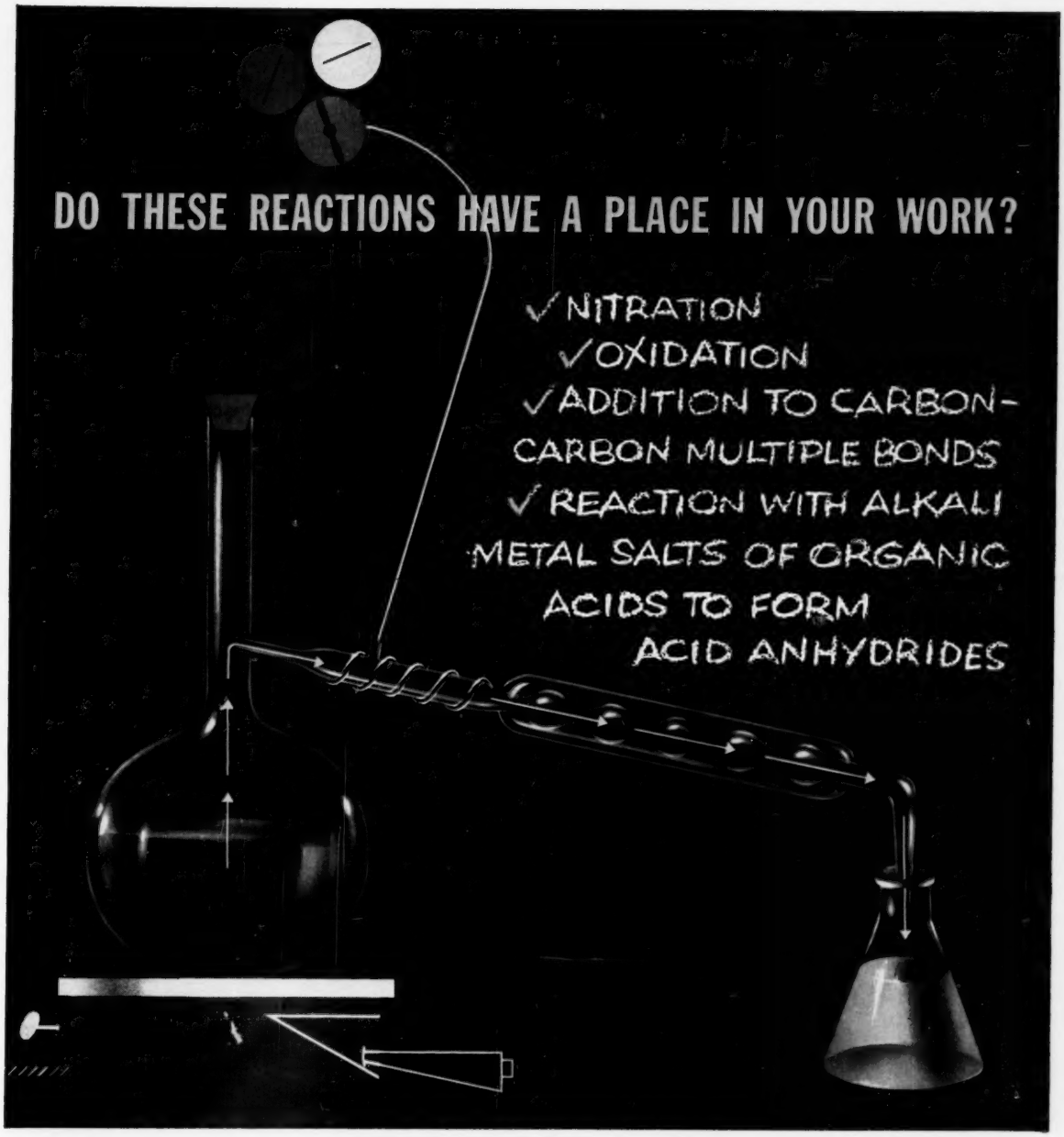
With maintenance costs at an all time high it is worth taking a careful look at the famous Sprout-Waldron Belt Saver® Pulley which has proven its ability to increase conveyor belt life from 50-400%. These cast iron wing and cone quality pulleys prevent crushing of the material between the face of the pulley and the bottom side of the belt. Sharp lumps and abrasive materials slide away from the pulley adding years of service life to the belt. Whether you are handling crushed stone, sand, asbestos, soda, limestone, cupola slag, salt, fertilizer, concrete, gravel or any other abrasive or difficult to handle material, Sprout-Waldron Belt Saver Pulleys can extend the life of your conveyor belts or bucket elevators and minimize your shutdown and maintenance costs.

The following chart which compares Sprout-Waldron cast wing Belt Saver Pulleys with fabricated wing pulleys tells its own story. Our unmatched experience is at your disposal.

Characteristics	*Sprout-Waldron Belt Saver Pulleys*	*Fabricated Pulleys*
Construction	Cast Iron	Fabricated
Outside Diameter	Precision ground to insure a smooth surface; crown is exact in pitch and is in dead center	Not ground; distortion during welding makes it difficult to maintain exact pitch of crown or to keep in exact center
Hubs	Both hubs are precision bored	Bored on one end only
Bore Length	Extra long to reduce shaft stress—3¾" bore length for 2 7/16" shaft	Short bore—2" bore length for 2 7/16" shaft
Ribs	Fewer ribs needed because belt contact area is greater	Extra ribs required, this means less space for large pieces to discharge. Greater possibility of damage

The above chart was made after careful examination of a widely advertised line of fabricated steel wing pulleys. All the points enumerated may not be true for every competitive pulley, but they are certainly worth your careful review.

CP/104


DO THESE REACTIONS HAVE A PLACE IN YOUR WORK?
✓NITRATION
✓OXIDATION
✓ADDITION TO CARBON-CARBON MULTIPLE BONDS
✓REACTION WITH ALKALI METAL SALTS OF ORGANIC ACIDS TO FORM ACID ANHYDRIDES

NITROGEN TETROXIDE may be the practical, economical reactant you've been looking for. N_2O_4 has been getting around a lot among research people. It is being used as an oxidizing agent for chemicals and solvents. It has potential as an oxidizer for rocket fuels . . . as a route from olefinic hydrocarbons to nitroso-nitrate derivatives . . . as a component of liquid explosives. Perhaps it will open another door for you.

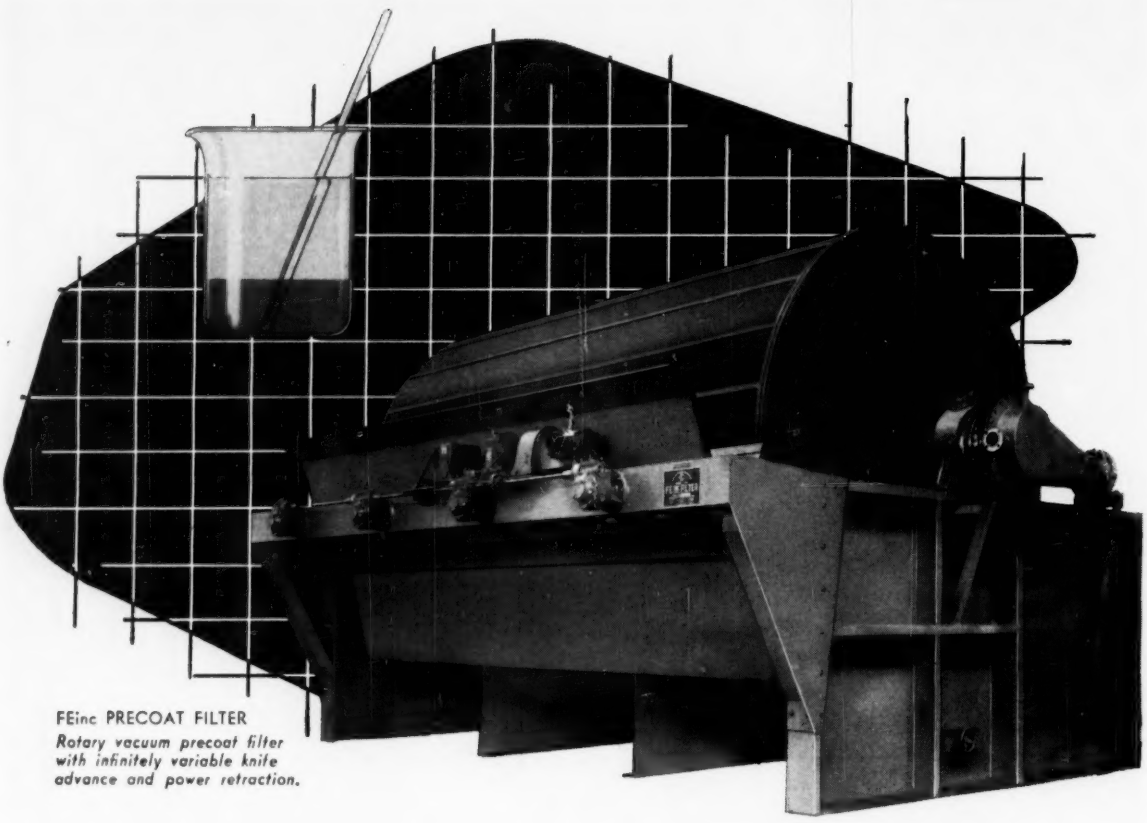
High-purity NITROGEN TETROXIDE is available from Allied in 125-pound cylinders or in tonnage quantities, at low cost. If the demand becomes evident, it can be produced in still larger quantity at still lower cost. It can be stored inexpensively in mild steel containers. Write for details on NITROGEN TETROXIDE as a reactant, and for technical assistance on your proposed application.

Properties of Allied NITROGEN TETROXIDE

Molecular Weight	92.02
Boiling Point	21°C
Freezing Point	−11.3°C
Critical Temperature	158°C
Latent Heat of Vaporization	99 cal/gm @ 21°C
Critical Pressure	99 atm.
Specific Heat of Liquid	0.36 cal/gm−10 to 20°C
Density of Liquid	1.45 at 20°C
Density of Gas	3.3 gm/liter 21°C, 1 atm.
Vapor Pressure	2 atm. at 35°C

Allied Chemical

NITROGEN DIVISION
Dept. NT 3-5-1, 40 Rector Street, New York 6, N.Y.



FEinc PRECOAT FILTER
Rotary vacuum precoat filter with infinitely variable knife advance and power retraction.

Custom Filter Design

BEGINS WITH YOUR FILTRATION PROBLEM

Your processing requirements are king at FEinc. They dictate the type of filter to be built, its size, the materials used, and the special refinements necessary to assure highest possible operating efficiency.

For example, a FEinc Precoat Filter designed to meet your particular needs pays off fast in trouble-free operation, dryer cake discharge and high clarity of effluent.

If you require higher output in limited floor area and a long filtration cycle coupled with the above advantages, FEinc *custom design* can give it to you.

Send us your filtration problems. Specific recommendations provided without obligation.

See our insert in Chemical Engineering Catalog

For a Bigger Yield **FE INC®**

FILTRATION ENGINEERS
AMERICAN MACHINE AND METALS, INC.
EAST MOLINE, ILLINOIS

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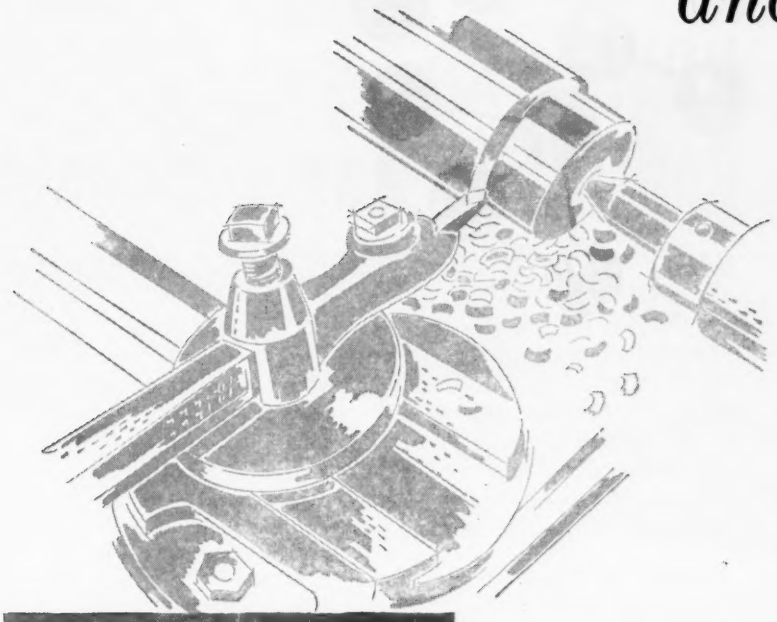
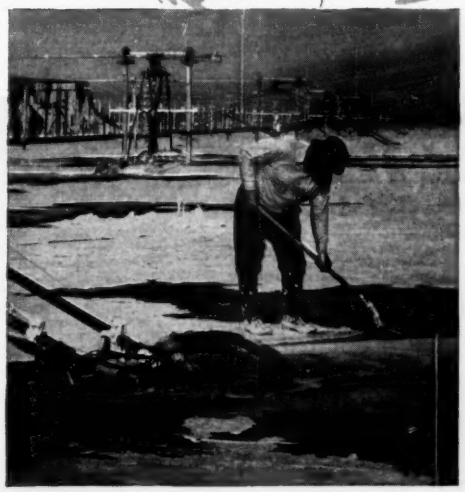
SPECIALISTS IN LIQUID-SOLIDS SEPARATION

SULPHUR

ONE OF THE FOUR STRONG PILLARS OF PROCESSING

SULPHUR *and* STEEL





This fact may not be too well known: the steel industry consumes about 7% of all the elemental Sulphur or Sulphur existing in the form of sulphur gases, etc., used in this country. Most of this Sulphur serves the steel industry in the form of Sulphuric Acid where it is used in pickling steel products but also to a considerable extent in plating them. And certain machine steels carry an appreciable amount of 'planted' Sulphur to impart desirable machining qualities. Seven percent of the total elemental Sulphur and equivalent Sulphur tonnage is quite substantial. Its use in steel emphasizes the importance of Sulphur to our whole economy. Much of this tonnage of steel-used Sulphur starts out at our mines in Texas where we serve as a major supplier of Sulphur to the manufacturers of Sulphuric Acid.

SULPHUR PRODUCING UNITS

• Newgulf, Texas • Spindletop, Texas
• Moss Bluff, Texas • Worland, Wyoming
• Fannett, Texas

TEXAS GULF SULPHUR CO.

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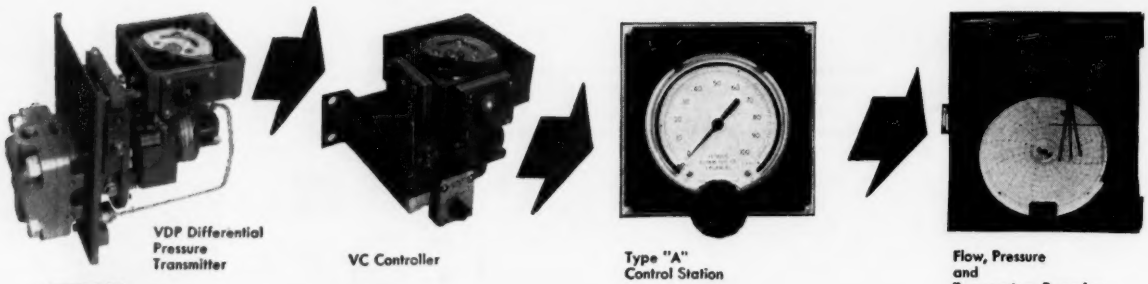
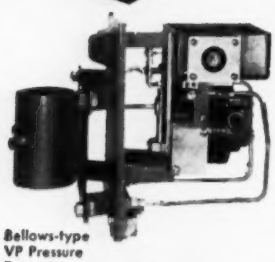


VDP Differential Pressure Transmitter

VC Controller

Type "A" Control Station

Flow, Pressure and Temperature Recorder



Bellows-type VP Pressure Transmitter

V-5 Gauges

Series 775 Final Drive

Diaphragm-type Angle Valve

NOW—
Control In Any Dimension
with standard Republic components

In order to fit your exact process control requirements, Republic now offers you a *complete* range of basic control components, which are (1) extremely accurate, (2) unusually versatile and (3) remarkably easy to combine into control systems.

For example: The differential pressure transmitter and controller illustrated are part of *a new family of pneumatic instruments*, developed to use the greatest possible number of *common* components. Because these Vector Series components can be interchanged—even among instruments performing entirely different *functions*—training and parts inventory are greatly simplified.

Radical changes in plant operating conditions present no problem when Vector instruments are used. Proportional band of the controller, for instance, is continuously adjustable from 2 to 500 per cent; the differential pressure transmitter has a range adjustment of 20 to 1, the pressure transmitter of as much as 10 to 1. Such adjustments are made simply by moving a link held by a lock screw. Re-zeroing is seldom needed.

Multi-point gauges with self-contained measuring elements are available for pressure, vacuum and differential. May also be used as receivers to indicate flow, CO_2, temperature or liquid level. Units may be grouped in any combination and substituted without disturbing other gauges. One- to four-pen recorders also available to measure these values.

Versatile Republic final drive units operate dampers, valves, inlet vanes and many other mechanisms. May be locally or remote controlled, by manual or automatic means. Proportionality of signal response can be tailored by a cam shaped on the job.

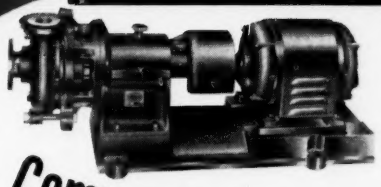
These are only a few of the many reasons why it is well worth while to consider versatile Republic components for your next (or existing!) control system. Your nearest Republic Sales Office will be delighted to assist . . . or contact Republic Flow Meters Company, 2240 Diversey Parkway, Chicago 47, Illinois. In Canada: Republic Flow Meters Canada, Ltd., Toronto. (Subsidiary of Rockwell Manufacturing Company)

REPUBLIC INSTRUMENTS AND CONTROLS
more fine products by
ROCKWELL

Many Industrial Plants Use Both

SAND PUMPS

WILFLEY



ACID PUMPS

Companions in Economical Operation

Industrial operations requiring both sand pumps and acid pumps are increasing almost daily. And now, more than ever before, efficient, low-cost pumping is a prime consideration. For this reason many plant operators choose the Wilfley team. They know Wilfley sand pumps and acid pumps consistently increase production and reduce operating costs. Wilfley's long-standing record of day-in, day-out dependability is a record *you* can rely on. Put Wilfley pumps to work now . . . every installation is job engineered to give you maximum efficiency and economy.

Write, wire or phone for complete details.

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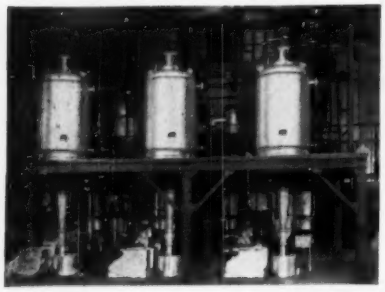
INDIVIDUAL ENGINEERING ON EVERY APPLICATION

RODNEY HUNT

FLUID PROCESSING

RODNEY HUNT MACHINE CO., Process Equipment Division, 31 VALE STREET, ORANGE, MASS.

QUALITY PARAFFIN IS PRODUCED AT A FRACTION OF A CENT PER POUND



Top quality, clear and odorless paraffin is produced continuously at a fraction of a cent per pound at the Trans Penn Wax Corporation in Titusville, Pennsylvania. To attain this paraffin purity, three Rodney Hunt Vacu-Film Processors are used. In this liquid process, as in many others, it has proven to be less expensive to increase the vacuum than the temperature.

Vacu-Film Processor

HIGH VACUUM PROCESSING

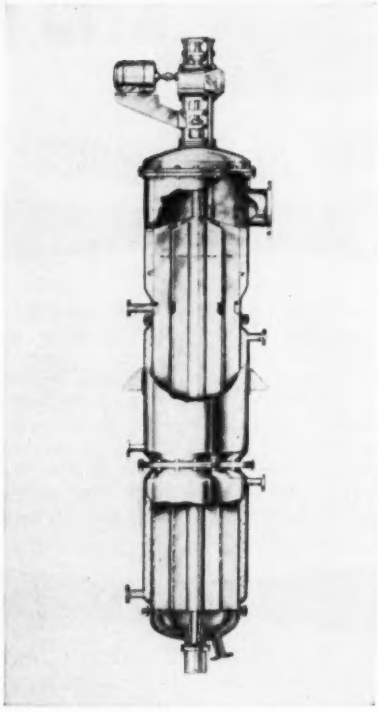
The Vacu-Film Processor has an alloy steel shell enclosing the rotor, shaft with wiper assembly, oil diffusion pump, oil seal, vertical condenser and entrainment separator. The alloy steel condenser is finned for efficient heat transfer and is water-cooled or refrigerated with circulating cooling fluid. Distillate and residue are separately discharged by oil-sealed positive pressure pumps. High vacuum is produced by conventional series coupling of high-speed gas ballast mechanical pumps and oil diffusion and oil ejector pumps.

IMPROVED QUALITY CONTROL ASSURED WITH RODNEY HUNT THIN-FILM TECHNIQUE

In one pass... continuously and rapidly... Rodney Hunt thin-film processing equipment achieves quality control of viscous fluids hitherto unobtainable by any other means. Only relatively small amounts of product are in process at any given moment. Therefore, the condition of the product can be checked continuously and controlled instantly to eliminate production errors and wasteful re-runs of reject material. This close control is particularly vital in the processing of delicate and temperature-sensitive materials. And this technique is especially effective in controlling the behavior of organic materials in high vacuum.

The Rodney Hunt Turba-Film Processor has wide applications in atmospheric and low vacuum ranges. The recently introduced Vacu-Film Processor extends the range of thin-film processing into high vacuum... to one-half micron. Installations presently in operation have delivered higher, purer yields than ever before possible in processing organic and inorganic chemicals, pharmaceuticals, latices, petroleum residues, solvents, food concentrates, vitamins and many other products.

Turba-Film Processor



MECHANICALLY AIDED THERMAL PROCESSING

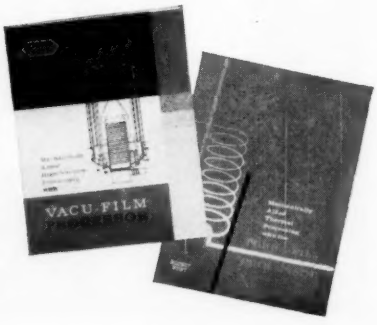
The Turba-Film Processor consists of a series of rotor blades operating within a thermal section and a separating section—all fabricated of alloy steel. Clearance between the rotor blade edges and the thermal section wall is exactly fixed to assure precise control of the film thickness. Vapor or gases pass upward through the thermal section to the separator from which entrained material is recycled to the thermal section. Steam, Dowtherm or other heating media is distributed in two or more compartments of the thermal section to assure a uniform temperature at the walls.

Solve Process Problems

Rodney Hunt welcomes specific requests for help in solving process problems involving mechanically aided heat and mass transfer, for product testing and for evaluation of processing techniques. Our fully equipped laboratory and pilot plant is staffed by engineers and technicians experienced in food, chemical, plastic and many other processing fields. They have tested hundreds of products in the laboratory and have compiled extensive records which provide basic data to expedite testing of new products. Customers may observe testing procedures and will receive complete reports. Test results obtained from pilot size Vacu-Film and Turba-Film Processors can be readily extrapolated to production size units.

For those who prefer to do their own testing, portable laboratory and pilot plant units are available for purchase or rental. Address your inquiry to the Rodney Hunt Process Equipment Division, 31 Vale Street, Orange, Mass. with details of your requirements. Literature on the Turba-Film Processor and the Laboratory Vacu-Film will be sent on request.

* * *



DEVELOPMENTS . . .

FEBRUARY 23, 1959

Chementator

C. H. CHILTON

Kaiser has come up with what is claimed to be a new crystalline form of activated alumina. Product, dubbed KA-101, is said to have just as high adsorptive capacity as alumina gel while selling at a much lower price. Kaiser also cites high physical strength of spherical form.

Sohio will commercialize a new acrylonitrile process based on propylene and ammonia. While not disclosing details, company asserts that process takes fewer steps than usual route via acetylene and HCN. Multimillion-dollar plant will be built this year at Lima, Ohio.

The ocean-going Methane Pioneer set sail Jan. 28 from Lake Charles, La., with a cargo of 32,000 bbl. of liquid methane at −258 F. Journey to Canvey Island, England, was expected to take about three weeks.

Labor relations, good and bad

The Lake Charles (La.) area, center of a complex of chemical plants and oil refineries, has been singled out by top union officials for a crackdown on wasteful labor practices. Decision to act was reached late in January at a Miami Beach meeting of international presidents of building trades unions.

The labor situation at Lake Charles, in the language of one on-the-spot observer, "stinks." Men loaf on the job, leave early, refuse to obey orders. Contractors employing non-union tradesmen have been crucified. Two chemical companies who had considered locating at Lake Charles have gone elsewhere.

The union presidents are sending representatives to Lake Charles to help enforce a ten-point code of fair labor practices. The code condemns slowdowns, featherbedding, production limits and early quitting, while upholding such employer rights as selection of craft foremen and full use of power tools.

Another approach to labor problems has recently come to light. This is the practice of running a chemical plant or refinery with salaried employees only; there is no hourly wageroll, no union, no distinction between labor and management.

Sun Oil has been using this plan at Sarnia, Ont., for five years. Two years ago Ethyl Corp. began operating a plant at Sarnia on a similar basis, and has recently extended the idea to its new plant at Pittsburg, Calif. Both Sun and Ethyl report enthusiastic acceptance of the "Sarnia Plan."

Check these routes to acrylonitrile

With acrylonitrile tagged as one of the brightest stars in the organic chemical firmament, potential producers will do well to look into two new vapor-phase, solid-catalyst processes now available for licensing. (Conventional process, as operated by American Cyanamid at Fortier, La., uses a liquid-phase reaction; see *Chem. Eng.*, Sept. 1955, pp. 288-291, also late report at left).

New CROUSE-HINDS EXPLOSION-PROOF MERCURY VAPOR LIGHTING FIXTURES

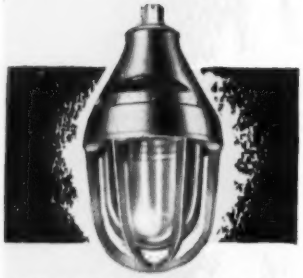
For dependable security at low operating cost in hazardous locations . . .

- *where long burning hours without interruption are involved, month in, month out*
- *where labor cost or trouble of relamping is an important factor*
- *where maximum lighting output calls for maximum economy in power consumption*

The longer life of mercury vapor lamps is well established: 7000 hours, *vs.* 1000 hours for incandescents. Light output is 2.5 times greater; 55 lumens/watt, *vs.* 22 lumens/watt for incandescents.

The new EV's place these economies within easy reach. As with all Crouse-Hinds explosion-proof devices, EV's are heavily constructed to withstand the pressure of internal explosions without rupturing. Gas-tightness is *not* a requirement for their safe performance. Flame-tight joints prevent the escape of flames to flammable atmospheres.

- *For full information, call your Crouse-Hinds distributor, or write for catalog sheet.*



TYPE EVA Explosion-Proof Lighting Fixture

Available with or without guard, or reflector (dome, deep bowl, shallow bowl, angle, or high bay)

250 Watt— National Electrical Code: Class I, Groups C & D

400 Watt— Class I, Group D

CROUSE HINDS

MAIN OFFICE AND FACTORY: SYRACUSE, NEW YORK

Crouse-Hinds Company of Canada, Ltd., Toronto, Ont.

• CONDULET® ELECTRICAL EQUIPMENT (Explosion-Proof and Conventional) • FLOODLIGHTING
• TRAFFIC CONTROL SYSTEMS • AIRPORT LIGHTING and WEATHER MEASURING EQUIPMENT

These products are sold exclusively through electrical distributors. For application engineering help, contact one of the following offices: Baton Rouge Birmingham Boston Buffalo Chicago Cincinnati Cleveland Corpus Christi Dallas Denver Detroit Houston Indianapolis Kansas City Los Angeles Milwaukee New Orleans New York Omaha Philadelphia Pittsburgh Portland, Ore. Salt Lake City St. Louis St. Paul San Francisco Seattle Tulsa Washington **Resident Representatives:** Albany Atlanta Baltimore Charlotte Chattanooga Jacksonville Reading, Pa. Richmond, Va. Shreveport

One new process represents the combined efforts of three professors at University of Osaka (Japan), plus the engineering assistance of Prof. Donald F. Othmer of Polytechnic Institute of Brooklyn. It involves reaction of acetylene with hydrogen cyanide over a fluidized-bed catalyst. The process has gone through two pilot-plant stages in Japan; Othmer is unable to confirm a report that it is in commercial use there.

The other process is being offered by Escambia Chemical Corp., New York. It has been through one pilot plant in the U. S., but a larger unit is now being built by an unidentified foreign chemical producer who intends to check out its commercial possibilities. While there's a chance that Escambia may decide to get into the AN business itself, the company is willing to talk to prospective licensees in this country.

Interesting feature of Escambia's process is its purported ability to operate on crude gas from a Sachsse process (partial oxidation) burner, containing only 4-12% acetylene. This implies high conversion efficiency, since recycle of unreacted acetylene under such conditions would hardly be practical.

Neither group will identify its catalyst; Escambia declines further to say whether its system uses a fixed, moving or fluidized bed. Othmer characterizes the Japanese catalyst as low-cost, long-lived and highly selective. Conversion efficiency of this process is reported to be over 92%, with a minimum of objectionable impurities in the product stream.

Latest moves in trade secret suits

Of two pending court actions involving chemical trade secrets, one has been settled by stipulation while the other is headed for trial.

Chemetron Corp.'s complaint against Catalysts & Chemicals Inc. for threatened disclosure of trade secrets, filed last October in New Castle County (Del.) Court of Chancery, was settled late last month. It apparently was a case of much ado about nothing.

In settlement of an earlier trade-secret hassle between CCI and Chemetron (*Chementator*, Apr. 21, 1958, p. 56), CCI agreed not to divulge to other parties certain confidential information regarding manufacture of catalysts. The recent suit was precipitated by allegations that CCI had subsequently offered such contraband information to European catalyst makers.

While denying the allegation, CCI has agreed to the stipulation which requires that CCI inform the European firms that it intends to honor the restrictions of the March 1958 settlement with Chemetron.

In the case of Monsanto vs. Central Farmers Fertilizer Co. (*Chementator*, Aug. 25, p. 51), a recent move by Monsanto to settle out of court got nowhere.

Claiming that the previous trial of Monsanto vs. Charles M. Miller actually decided the basic issues involved in the pending CFFC suit, Monsanto suggested that CFFC agree to a ten-year policing of its elemental phosphorus operations at Georgetown, Idaho, to insure that Monsanto trade secrets were not being used. CFFC was not willing to accept a period as long as ten years, and negotiations bogged down over that point. Case will go to trial at Pocatello, Idaho, next month.

Meanwhile, in the Monsanto-Heyden-Kellogg dispute over engineering of the Texas City methanol plant (*Chementator*, Feb. 9, p. 55), court actions in both New York and Wilmington have been postponed until next month.

Halogens boost butyl rubber's stock

Butyl rubber's song of the open road may once again accelerate its tempo, and in a new key signature—Br.

Bromination of butyl rubber produces a material which B. F. Goodrich has been quietly grooming during the past three or four years for use in tires. Called Hycar 2202, the new brominated butyl can be used as a tire liner or as an adhesive in retreading, or can be blended with both natural and synthetic rubber. Proportions as large as 40-50% Hycar 2202 in mixtures with natural rubber are mentioned by Goodrich researchers as optimum for ozone resistance.

Butyl rubber's biggest market—inner tubes—has been hard hit with advent of the tubeless tire. Despite a rumor last fall that certain 1959 luxury autos would come equipped with the all-butyl tire foreseen by Esso over two years ago, such a development is apparently still around the corner.

In fact, Esso is at work on a halogenated butyl of its own—a chlorinated product called MD 551. The company operates a pilot plant at Baton Rouge, selling its product for 35¢/lb.

(Continued on page 60)

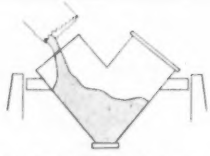
ENTIRELY NEW PRINCIPLE enables you to . . .

Blend

liquids and solids intimately in one operation

It is now practical, with the P-K "Twin-Shell"* blender, to blend many difficult formulations that have heretofore been either impossible or impractical because of the number of separate operations required to achieve a desired product. With the new "Twin-Shell" blender, liquids, solids, clumpy and crystalline materials can all be intimately blended in one operation. Average blending time: 5 to 15 minutes. The P-K "Twin-Shell" blender is unlike any other blender. It works on an entirely new blending principle. Here, in diagram, is how it works.

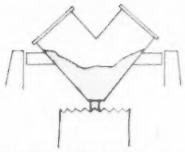
*Patented



CHARGE DRY SOLIDS through top of either shell. Optimum charge level for most materials is about 65% of total shell volume.

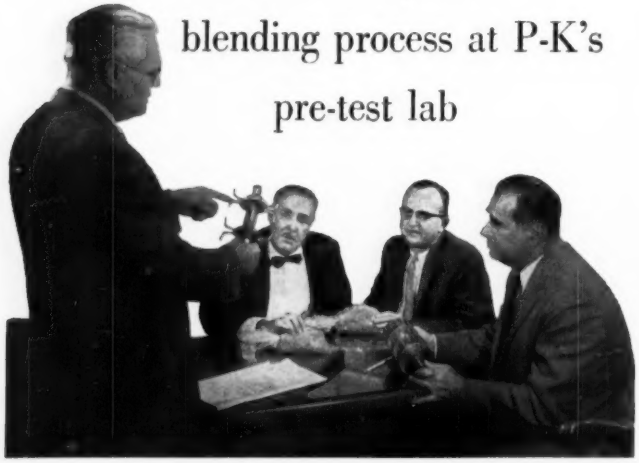
TUMBLE AND AERATE. As shell revolves, rapidly spinning wire cage intensifier breaks up agglomerates, literally creates dust storm in material.

ADD LIQUID. Centrifugal force sprays atomized liquids from periphery of control discs on Liquid-Feed Bar into finely dispersed solids.



DISCHARGE PRODUCT easily through apex of shells. Accessibility of interior and easy removal of Liquid-Feed Bar speed cleaning.

Get new ideas for your blending process at P-K's pre-test lab



Complete, scientific investigation of all types of blenders now available at Patterson-Kelley.

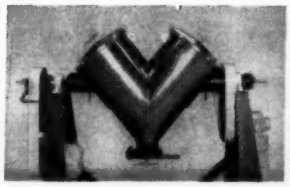
Blending of complex formulations is full of variables. The equipment and procedure that are ideal for one combination of ingredients may be unsatisfactory for another. Proper selection of equipment demands thorough scientific investigation. You can conduct your investigation at Patterson-Kelley's Customer Pre-Test Lab, at East Stroudsburg, Pennsylvania. Since P-K makes practically all types of blenders, you can run conclusive comparison tests with your materials. Trained technicians will help you.

To set up an appointment, just place a collect call to Russell Dotter at Patterson-Kelley. Tel. No.: Stroudsburg 820. He'll be happy to tell you how much of your materials to bring and to give you other details. East Stroudsburg, in the Pocono Mountains, is just 2 hours from New York City, easily accessible by all carriers.

PROBLEM: to blend:—precisely—varying amounts of
lumpy solids, powders, crystalline materials and small amounts of liquid.

SOLUTION: Charge materials to P-K
"Twin-Shell" Liquid-Solids Blender. Press start button.

"TWIN-SHELL" Liquid-Solids laboratory models are made in transparent Lucite or stainless steel, in 8 and 16 quart sizes.



PRODUCTION MODELS of the "Twin-Shell" blender range up to 50 cu. ft. capacity. (Intensifier and Liquid-Feed Bar optional.)

VACUUM TUMBLE DRYERS by Patterson-Kelley are available in sizes down to the standard 1 cu. ft. capacity lab model.

PRODUCTION MODELS of the Vacuum Tumble Drier have capacities up to 150 cu. ft., come factory aligned, piped, instrumented.

BLENDER LITERATURE. Specialized information and data in greater detail are given in two Patterson-Kelley publications: Bulletin No. 16, Chemical Process Equipment and Bulletin No. 15A-1, Twin-Shell Laboratory Blenders. Write for your copies today. Patterson-Kelley Company, Chemical and Process Equipment Division, 1502 Hanson St., East Stroudsburg, Pa. 15.

Patterson Kelley

Chemical and Process Equipment Division

Anticipated price upon volume production is 30¢/lb.

Goodrich, selling the brominated compound for 65¢/lb., claims better adhesion to other rubbers, fabrics and metals for its product. Whereas straight and chlorinated butyl bonds fail at pulls of 10-15 lb./in. width, Hycar 2202 is said to take up to 50 lb. And tensile strengths of Hycar 2202 blends with other polymers are significantly better than blends using chlorinated butyl, claims Goodrich.

Esso, on the other hand, is selling chlorinated butyl on the strength of its heat resistance. Curing-press bladders of MD 551 can produce an average of 625 tires at 385 F., says Esso. Conventional bladders wear out under similar conditions after only some 200 tires.

Industry observers speculate that production of halogenated butyls might end up as a cooperative effort of Esso and Goodrich. Goodrich-Gulf is already one of Esso's two U. S. butyl rubber licensees.

The other licensee, Petroleum Chemicals Inc., might also enter the picture. PCI is dusting off plans for a butyl rubber plant at Lake Charles, La., first announced two years ago (*Chementator*, Apr. 1957, p. 146) but later shelved. Thiokol Chemical Corp., which was to act as sales agent for PCI's butyl, has meanwhile been building up valuable know-how via marketing some of Esso's butyl. Speculation now is that Thiokol will join PCI's parents, Continental Oil and Cities Service, in three-way ownership of the proposed butyl plant.

New technique cuts catalyst losses

Users of catalysts will be interested in a new synthetic cracking catalyst—Durabead—developed recently by Socony Mobil Oil Co. By a special processing step, Socony gives bead catalysts an improved physical ruggedness which can lower attrition losses in moving-bed applications by 40-70%, with no reduction in catalytic activity.

Socony first started using Durabead in its own Thermofor cracking units about a year ago. Six months later the company began replacing catalyst charges in units operated by TCC licensees.

In addition to better physical strength, Durabead catalyst with pore diameters of 100 Angstroms burns more easily in regenerative operations than ordinary bead catalysts with pore sizes half as large. Kiln-burning capacities haves been increased as much as 40%.

Novel feature of Durabead's manufacture—by a process still in the patent-application stage—is that part of the finished product is ground to micron size and fed back into the main stream of liquid gel, forming a heterogeneous, glassy structure. This technique gives a product of lower compressive strength but higher impact strength than regular bead catalyst. Thus its elastic structure can absorb more shock without breaking.

Another method for making abrasion-resistant catalysts for moving-bed units was announced last year (*Chementator*, May 5, p. 48) by California Research Corp. CRC's process involves chemical treatment of an extruded or bead catalyst during normal operation of the cracking unit.

Socony now makes Durabead at Paulsboro, N. J. Selling price is the same as the older bead catalyst, no longer being made.

Though Durabead has been used so far only in cracking operations, Socony feels there may be other applications for it, such as serving as a base for other catalysts. And the technique by which it's made might find use in other chemical processes.

Tomorrow's Technology

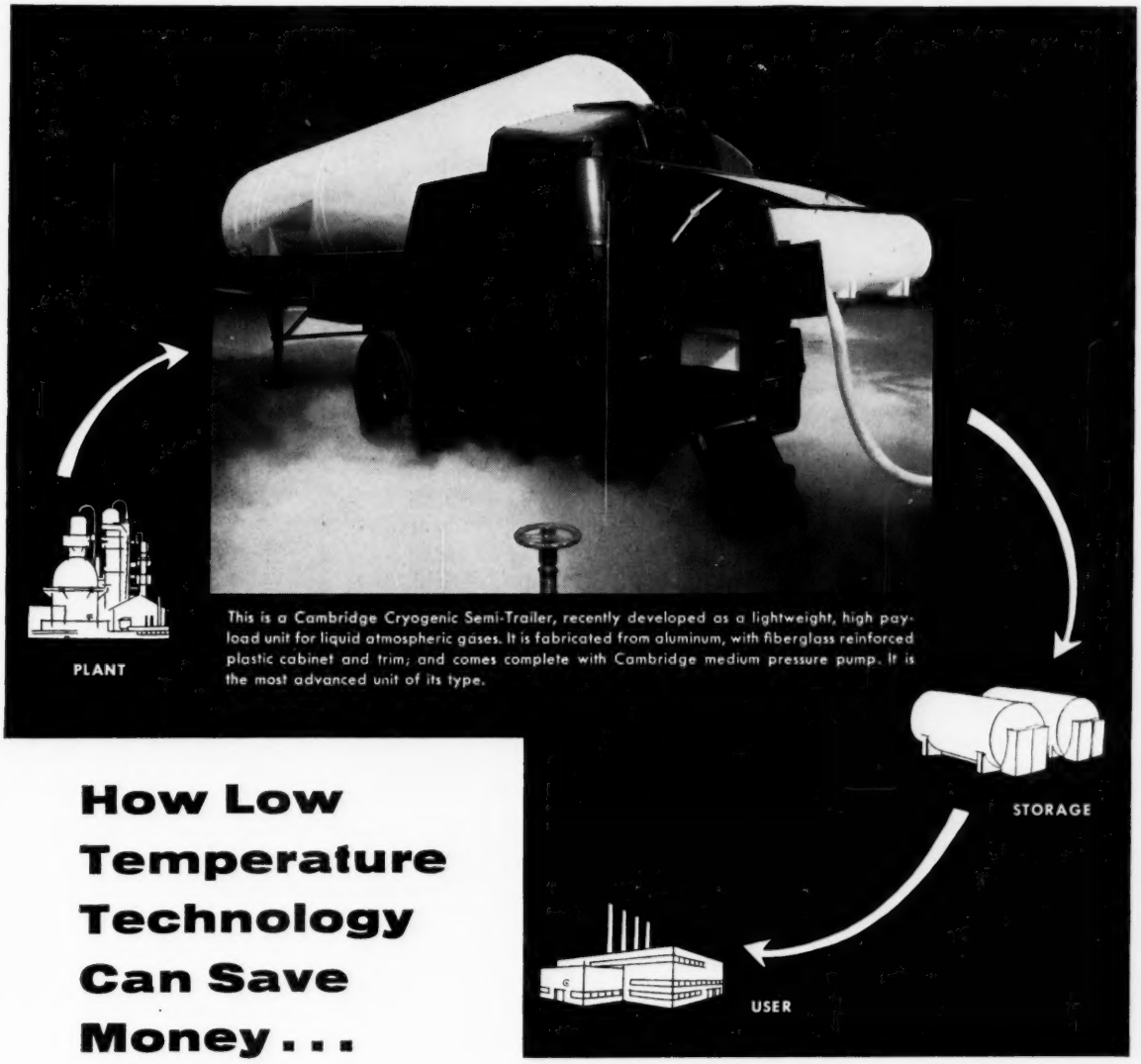
Today's embryonic developments which have special significance for chemical engineers

Needed: New gasification technology

If underground gasification of coal ever becomes economically feasible under conditions of free competition, there will have to be a major breakthrough in technology.

This is the conclusion drawn recently both here and in Great Britain. U. S. Bureau of Mines expects to close down its experimental underground gasification project at Gorgas, Ala., within a few months. And Britain's National Coal Board has just announced that it will abandon its development operations at Newman Spinney this summer.

The British pilot plant has produced small quantities of gas to help generate power from a temporary station on the site. Originally it was intended that gas from the thin, faulted coal seams at Newman Spinney be used in a 60-mw. power station to be built next year. Commercial prospects today, however, don't justify further expenditure, say British authorities. The tests have already cost over $4.5



This is a Cambridge Cryogenic Semi-Trailer, recently developed as a lightweight, high payload unit for liquid atmospheric gases. It is fabricated from aluminum, with fiberglass reinforced plastic cabinet and trim; and comes complete with Cambridge medium pressure pump. It is the most advanced unit of its type.

How Low Temperature Technology Can Save Money . . .

In Storage, Transportation, Distribution

The application of cryogenics — low temperature technology — holds tremendous promise for reducing costs and improving processes. It simplifies handling, cuts storage space and gives a brand-new dimension to "liquid logistics".

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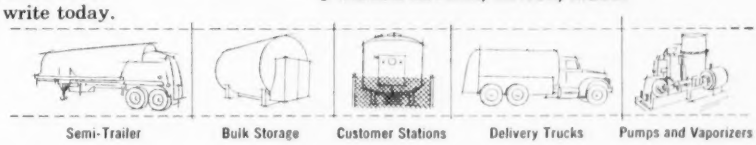


CC 9-2

million. (Bureau of Mines has spent $2.5 million, not counting the costs borne by Alabama Power Co.)

First step in underground gasification is to prepare the coal seam, making it porous enough for gasification. USBM tried three methods at Gorgas:

- Simple preliminary mining.
- Electrolinking (passing a heavy current through the bed), which causes carbonization and creates pores.
- Hydraulic fracturing, a technique borrowed from the petroleum industry.

All these methods worked, but none was really cheap enough.

To gasify the coal, bureau engineers would ignite the coal at one hole and blow air (or oxygen) into the porous bed until it burned a path to another hole. Both forward burning (with the air flow) and backward burning (against the air flow) were tried, but only backward burning seemed successful. The other direction would clog the pores once again.

Air blowing yielded a gas varying between 80 and 120 Btu./cu. ft. This is too poor for much of anything, except perhaps burning in a gas turbine to generate electricity (which is what the Russians claim to be doing on a commercial basis outside Moscow). Oxygen gave a gas of only 125 Btu., and at a prohibitive cost.

Concludes the bureau in its recent annual report: "A new technology and process appear to be needed to make underground gas from such coal beds economically attractive."

Now: Fluorocarbons directly from coal

Researchers at the British Coal Utilization Assn.'s laboratories have succeeded in fluorinating coal to make liquid products with properties similar to those of commercial perfluorocarbons.

Process involves reaction of low-grade coal with gaseous chlorine trifluoride diluted with nitrogen. Chief product is an oil analyzing 25% C, 65% F and 7% Cl, with a wide boiling range (80% between 150 and 350 C.). Smaller quantities of a thermoplastic resin and material of a waxy consistency are also obtained.

The highly fluorinated liquids may be useful as lubricants, heat-transfer media, dielectric and hydraulic fluids. The gaseous products of the reaction have not yet been investigated, but the British chemists say they may contain low-molecular-weight compounds similar to those widely used as refrigerants and aerosol propellants.

Tar sands to get shock treatment

Plans for applying a nuclear explosion to production of oil from Canada's Athabasca tar sands began to take definite shape last month as Richfield Oil opened negotiations with Canadian government officials.

Proposed program calls for detonation of a small nuclear device at a depth of 1,200-1,400 ft., underneath a 200-ft. bed of tar sands. Anticipated effect of the detonation is twofold:

- Pressure of the blast will break up the sand, making it more permeable.
- Heat from the blast will convert the solid bitumen to a liquid thin enough to pump from the ground through drill pipe.

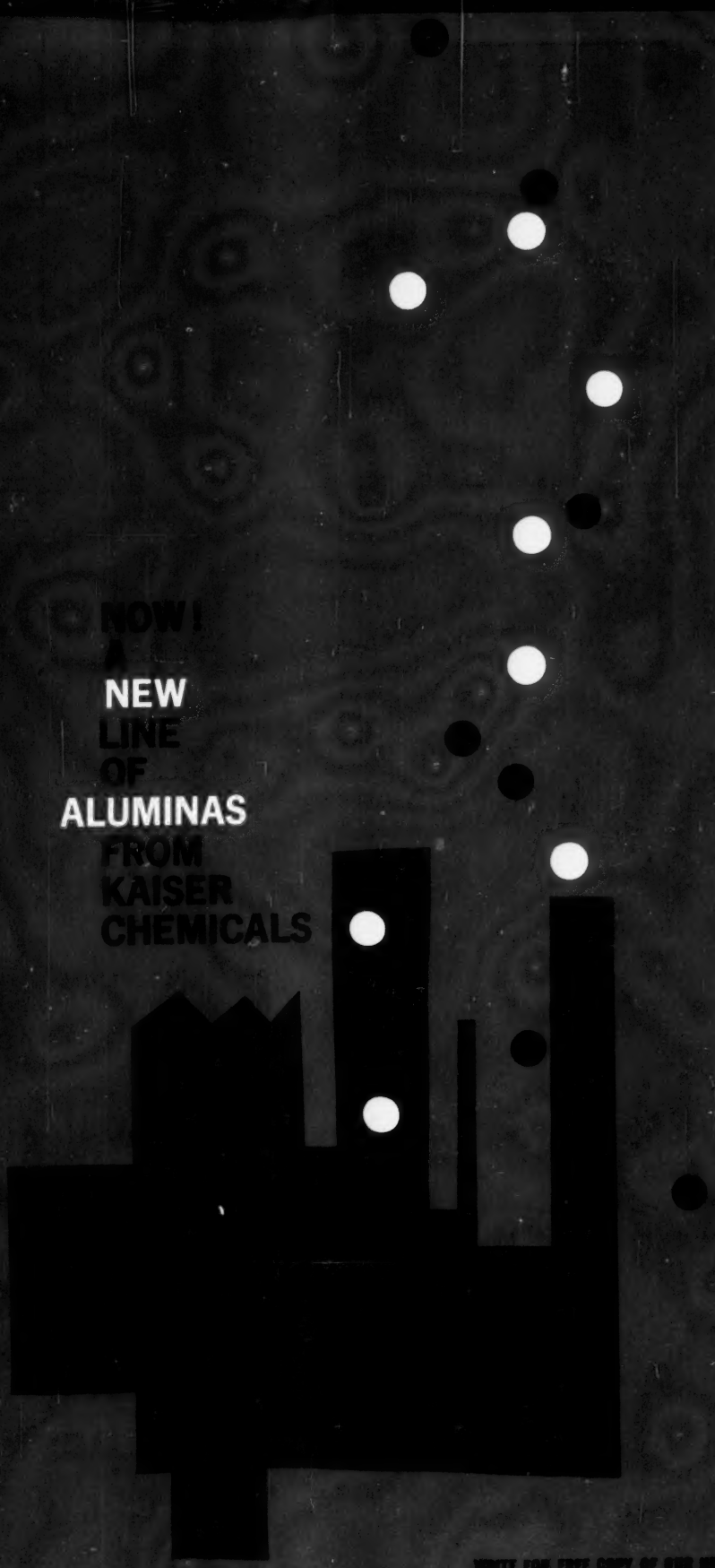
Probable size of the first bomb is 2 kilotons. If this blast shows promise, a second shot may be 10 kilotons; 100 kilotons is visualized as an ultimate limit. Target date for first explosion is latter part of next year.

Project represents a cooperative venture involving, besides Richfield, both the Provincial (Alberta) and Dominion governments as well as the USAEC. Cost, estimated at about $1 million, will be borne chiefly by Richfield.

At stake in this venture is a rich prize. The Athabasca tar sands, covering an area of 17,000 sq. mi., represent a potential crude oil source equal to twice the world's known recoverable supplies of petroleum. Various schemes which have been advanced to date for mining and processing the sands are limited to the 2% of the total deposits minable by today's technology. The other 98% can't be mined by any known conventional method, asserts John Convey, director of the Canadian Department of Mines & Technical Surveys, Ottawa.

There are still political obstacles to be overcome. In addition to the UN ban on testing of nuclear weapons, the Canadian government does not allow nuclear weapons on its soil. Convey feels, however, that authorities will agree that a nuclear device designed for peaceful purposes falls outside the definition of "weapons."

For more on DEVELOPMENTS.....64



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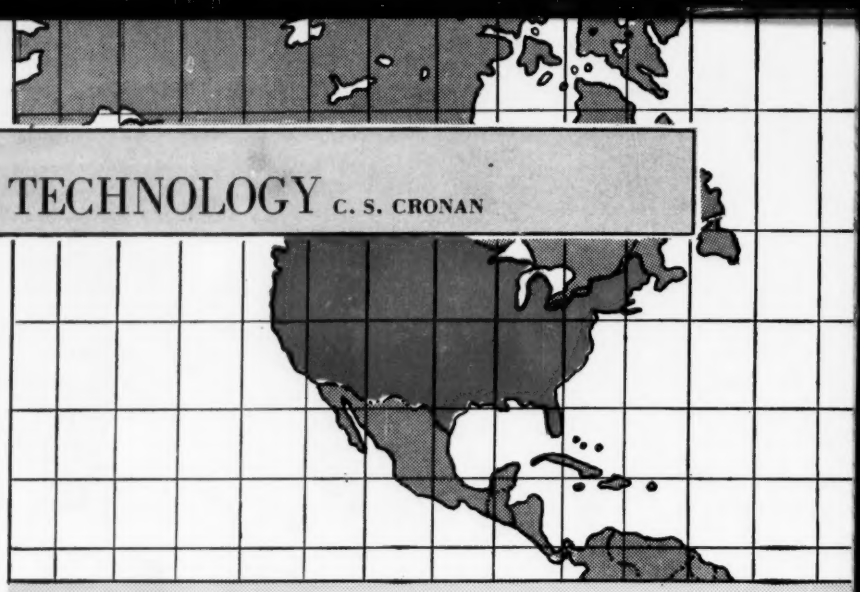


United States

Savannah River, Ga.
- **Processes**
  - Dual temperature exchange
  - Water distillation
  - Electrolysis
- **Production**
  - Large scale

Boulder, Colo.
- **Process**
  - Hydrogen distillation
- **Production**
  - Pilot scale

England

Manchester
- **Process**
  - Hydrogen distillation
- **Production**
  - Pilot scale

France

Toulouse
- **Process**
  - Hydrogen distillation
- **Production**
  - 40 ton/yr.

Switzerland

Winterhur
- **Process**
  - Hydrogen distillation
- **Production**
  - Pilot scale

Free-World Engineers Map New Heavy Water

Spurred by reactor needs, process engineers now strive to make heavy water on commercial basis in new facilities around the world.

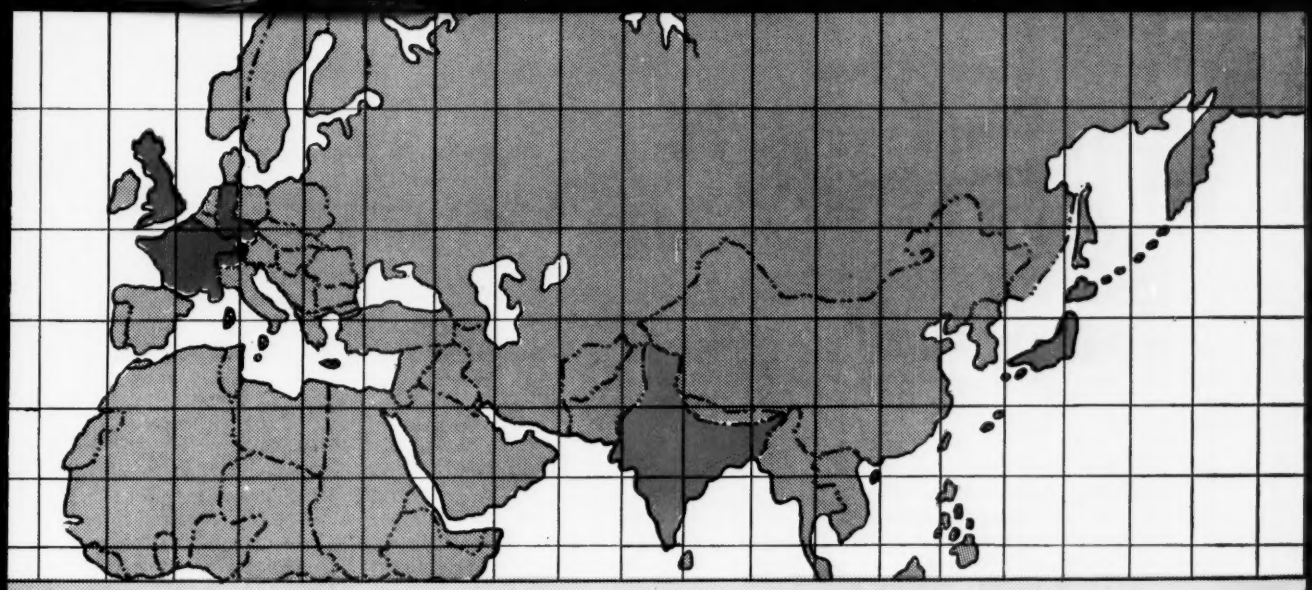
Now, and in the immediate future, chemical engineers must satisfy need for increasing amounts of heavy water to moderate and cool nuclear reactors, planned or abuilding.

With outstanding ability to slow down neutrons, yet not absorb them, heavy water plays a vital role in moderation of natural or slightly enriched uranium fuel. And it is a definite factor in some designs operating at a higher enrichment, as well.

To give domestic nuclear power the heavy water it needs, at a price it can afford, engineers are striving to domesticate production technology born out of military necessity.

▶ **Full Scale** — At the moment, the AEC Savannah River plant offers the only U. S. source of heavy water which is sold to qualified customers in quantities up to 400 lb. at $28/lb. or 4%/yr. rental charge. To produce its product, Savannah River uses three processes in combination: dual-temperature exchange, water distillation and electrolysis.

Iceland is believed to be considering use of dual-temperature exchange for a proposed $40-million, 100 ton/yr. heavy water plant. And Japan may eventually



Germany

Frankfurt, a. M.
Process
Hydrogen distillation
Production
6 ton/yr.

Butzbach
Process
Dual temperature exchange
Production
Pilot, ultimate 36 ton/yr.

India

Bakra Dam
Process
Electrolysis
Hydrogen distillation
Production
14 ton/yr.

Japan

Tokyo
Process
Electrolysis
Water distillation
Electrolysis
Production
100 kg.; ultimate 10 ton/yr.

EXCLUSIVE—First details on hydrogen-distillation plant, p. 68.

Processes and Plants for Nuclear Future

turn to this process, when it reaches the point where a 30-ton/yr. plant is needed.

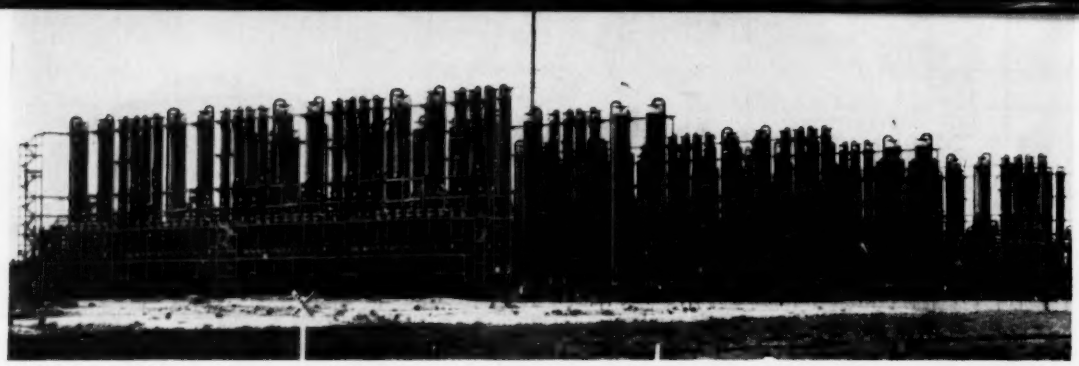
Among activities abroad, Farbwerke Hoechst A. G. is the first company to announce successful, commercial production of heavy water via distillation of hydrogen in a 6-ton (metric)/yr. plant using German Linde process. And the same process is going into a 14-ton/yr. plant under construction in a new chemical complex in India owned by Nangal Fertilizer and Chemicals. Ltd. (For details, see story pp. 68-70. A similar chemical complex, including heavy water production is under consideration by the United Arab Republic.

In France, L'Air Liquide Co. has built a 40-ton/yr. hydrogen distillation plant for the French Atomic Energy Commission, using a design developed during 5-yr. program.

▶ **Pilot Scale** — Working on an AEC contract, the Cryogenics Engineering Laboratory operated by National Bureau of Standards at Boulder, Colo., is now conducting pilot runs to determine how to build a commercial-scale hydrogen distillation plant.

At Butzbach, Germany, the Pintsch-Bamag A. G. has just finished building a 0.5-ton/yr. dual-temperature-exchange pilot plant. Upon completion of pilot studies, firm hopes to erect a 36-ton/yr. plant.

Reports from Sulzer Bros., Winterhur, Switzerland, indicate superior distillation performance for the Kuhn column (*Chem. Eng.*, Oct. 1956, pp. 246-248) on heavy water pilot runs. These



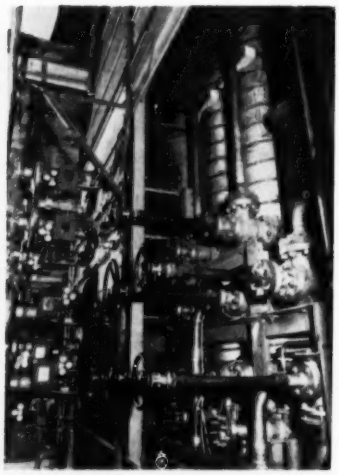
UNITED STATES: Towers at AEC Savannah river plant indicate scale of U. S. heavy water production.

data and additional data from successful distillation of hydrogen provided bases for design of a heavy water plant which Sulzer is offering commercially.

In Japan, Showa Denko K. K. now operates for the Japanese Atomic Energy Commission a 100-kg./yr. heavy water plant using electrolysis, water distillation and electrolysis stages. The same scheme will be followed in projected 10-ton/yr. plant.

Recently, Petrocarbon, Ltd., piloted in England a hydrogen distillation process similar to Sulzers. Operating in conjunction with an ammonia synthesis plant, process could be expected to produce heavy water at $38/lb. cost.

▶**One Part in 6,500**—Starting material for production of heavy water is hydrogen, either free or combined. In either case, wherever common hydrogen (atomic wt. 1) occurs, heavy hydrogen or deuterium (atomic wt. 2) is present in the amount of 1 part in 6,500 of light hydrogen.



FRANCE: This view shows some of 40 ton/yr. Toulouse plant.

As indicated in the foregoing roundup of heavy water activities around the world, there are a number of ways to recover this trace of heavy hydrogen. Actually, no one process can be considered clearly superior throughout the entire range from one part in 6,500 to 99.8% D_2O.

▶**Recover From Water**—For instance, at Savannah River, three processes in tandem concentrate the heavy water.

Entering the dual-temperature-exchange process, water undergoes deuterium enrichment from contact with H_2S-D_2S mixture at low temperature. Some of this enriched water passes to low-temperature tower of next stage for further enrichment.

Remainder of enriched water goes to high-temperature tower where deuterium tends to transfer back into same stream of H_2S. Water, which is now depleted, leaves tower while enriched H_2S-D_2S recycles to low-temperature tower to repeat its enrichment of incoming water.

Water discharging from the dual-temperature exchange contains 15-20% D_2O. If rate of incoming feed were 70,000 lb./hr. (84,000 gal./hr.), product rate would be 54-72 lb./hr. (6-8 gph.), depending upon concentration.

Next, the water undergoes distillation to raise D_2O content to 90%. Electrolysis completes final concentration to 99.8% D_2O. Differences in rates of vaporization and decomposition, respectively, provide the bases for these two process steps.

▶**Recover From Hydrogen**—Major emphasis now focuses on concentration of deuterium by distilling hydrogen. Potentially favorable economics lie behind this trend despite major difficulties involved in operating at extremely low temperatures and in handling liquid hydrogen.

Although many variations of hydrogen distillation are operating or under study, all rely on difference in volatility between D_2 and HD on one hand and H_2 on the other.

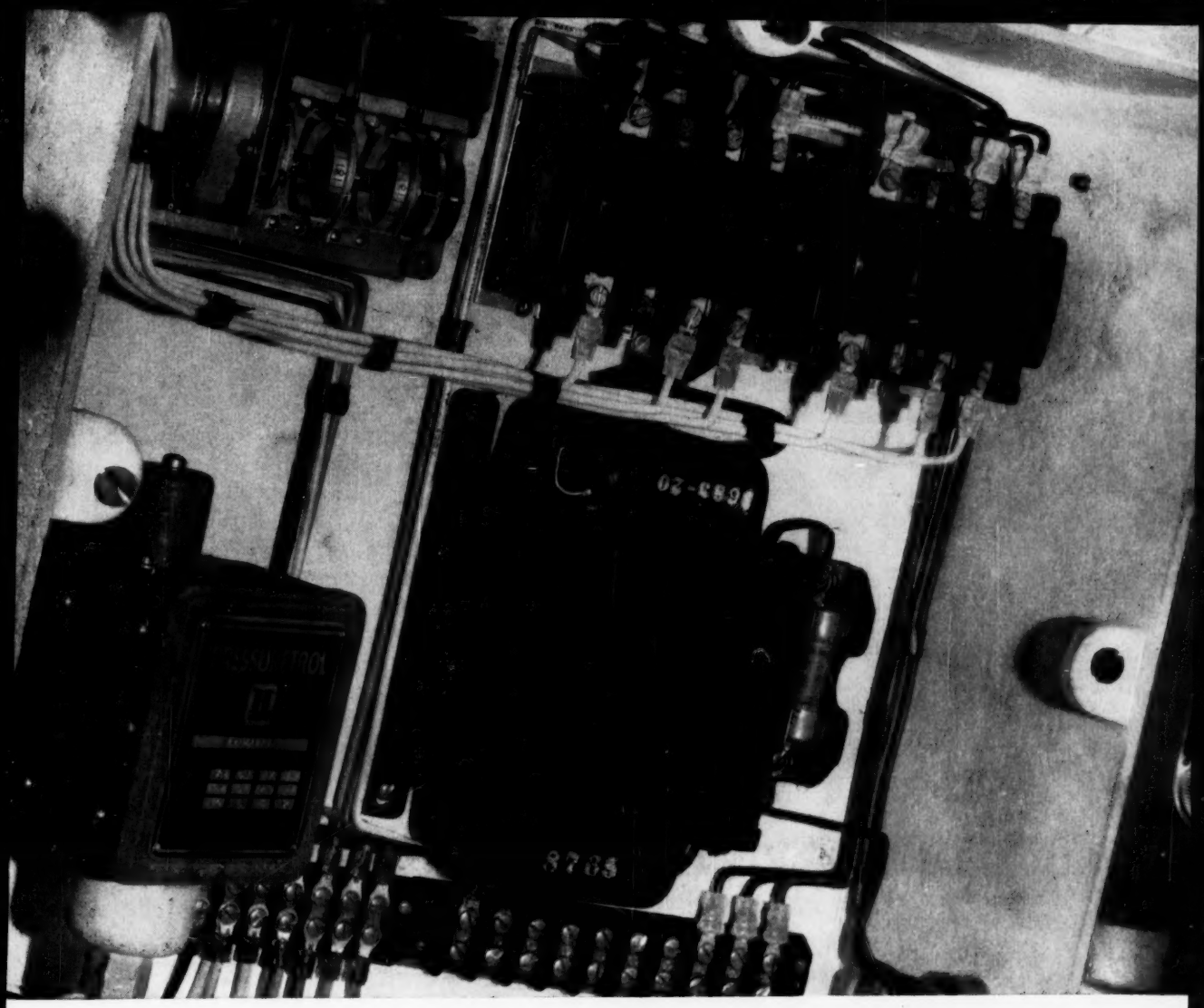
In the U. S., Hydrocarbon Research, Inc., undertook development and design of a hydrogen distillation process for the AEC in 1950-51. Starting with supply of H_2 such as ammonia synthesis plant feed, process liquefies the gas and removes solidified nitrogen with cold traps. Distillation concentrates deuterium which is then catalytically converted from HD form to H_2 and D_2. Distillation of this mixture produces pure deuterium which is burned with oxygen to form heavy water.

Gaps in the technology of ultra-low-temperature distillation and resulting prohibitive costs prevented use of this process at Savannah River. But now, the Cryogenics Engineering Laboratory at Boulder, Colo., is working to eliminate these earlier shortcomings.

L'Air Liquide's 40-ton hydrogen distillation plant at Toulouse, France, is reported to use a process similar to the one proposed by Hydrocarbon Research. Feed gas is hydrogen produced electrolytically for ammonia synthesis.

Hydrogen method proposed by Sulzer Bros. begins with water electrolysis to produce HD-enriched hydrogen. This material is then distilled in a Kuhn column to increase HD enrichment. Combustion of H_2-HD mixture produces D_2O-H_2O which is purified to 99.8% D_2O by final Kuhn distillation.

Hydrogen distillation process developed by German Linde is described in first story about a commercial installation starting on p. 68.



For "set it and forget it" gas drying—

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Note the precision with which even the wiring is connected. It's typical of the thorough workmanship going into every component of the Kemp Dryer. Kemp Dryers are built with care; built to last and perform year after year with dependability resulting from a quarter century's experience.

Whether your operation calls for a completely automatic Kemp Dryer, a semi-automatic model, or a simple, manually operated unit, there's a model and capacity to meet your needs. Kemp Field Engineers will gladly study your problem and make complete recommendations, even down to the proper desiccant (we select from over 20) to do your job best.

Call in your Kemp Representative when you plan a new installation or wish to up-date an old one. He'll give you full information. Or write direct and ask for Bulletin D-102: THE C. M. KEMP MFG. CO., 405 E. Oliver Street, Baltimore 2, Maryland.

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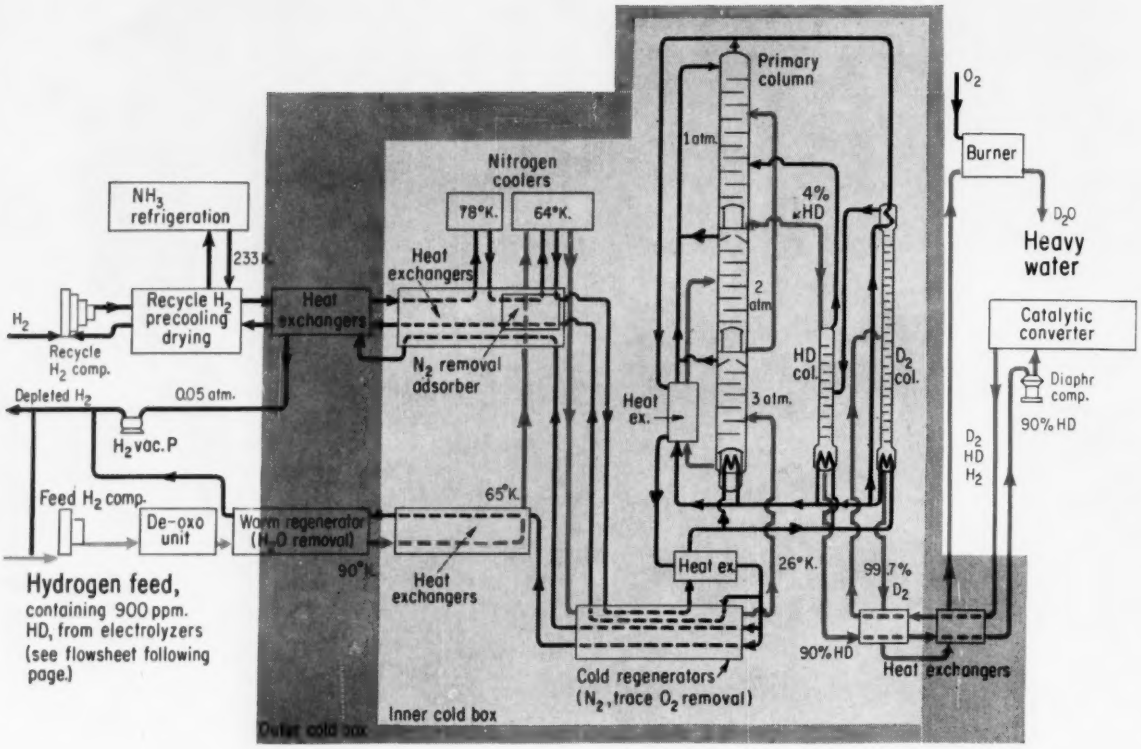


How Linde Makes Heavy Water From Hydrogen

For the first time, German Linde discloses how its hydrogen distillation process works successfully in a commercial heavy-water plant.

True to the tradition of Germany's outstanding position in the world of technology, process developed by Gessellschaft fur Linde's Eismaschinen A. G. is the first to successfully produce heavy water by hydrogen distillation on a production scale.

Farbwerke Hoechst A. G. announced late last year that their 6-ton/yr., hydrogen-distillation, heavy-water plant, designed for them by German Linde was operating successfully.

Because of its success, India's Nangal Fertilizer and Chemicals (private), Ltd., licensed the German Linde process for their 14-ton/yr. heavy water plant, now under construction. Heavy-water plant will be linked to a $46-million, ammonium nitrate fertilizer plant being built near Bhakra Dam on the Sutlej River. Vitro Engineering Co., New York, is designer and constructor.

▶ **Built-In Economics**—Because of built-in, economic features of the Nangal plant, heavy-water price will undercut U. S. AEC's $28/lb.

Unique German-Linde process techniques minimize costly refrigeration, thus make the process profitable. Complex recycle system maximizes refrigeration utilization, while enclosure of low-temperature process equipment within insulated boxes minimizes refrigeration losses.

And heavy water plant, linked to ammonium-nitrate plant, will not bear the full load of hydrogen-production costs.

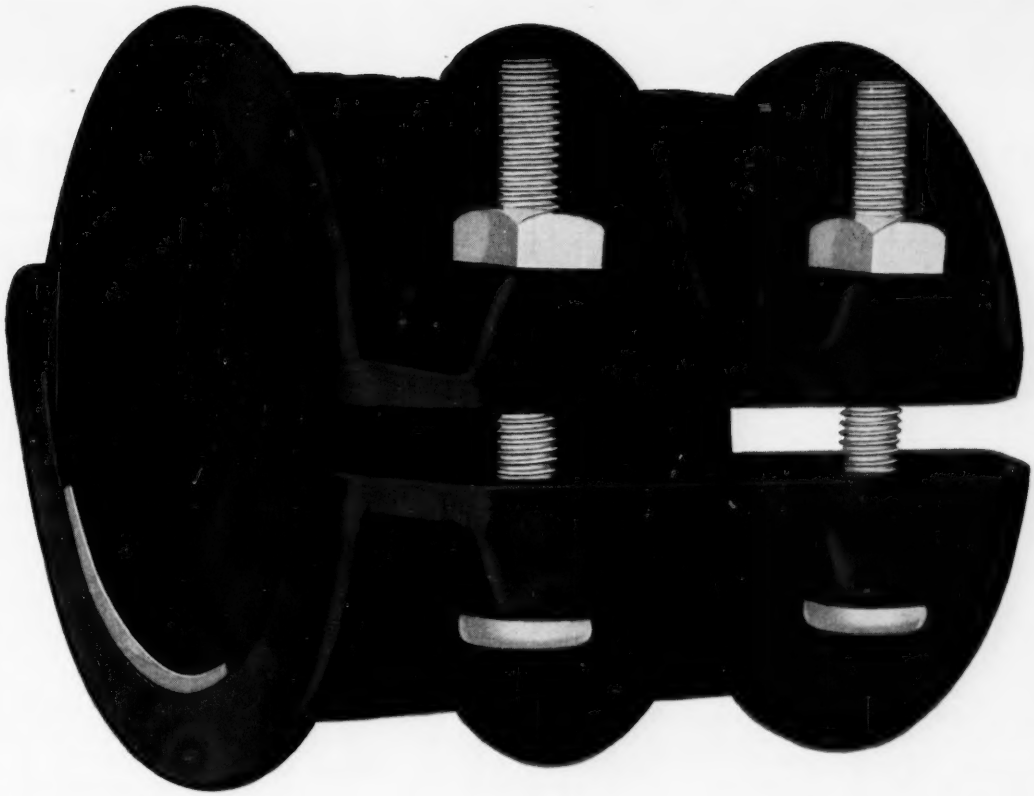
Too, capitalizing on low electric-power costs prevailing at Bhakra, hydrogen will be produced via water electrolysis. Resulting electrolytic hydrogen, enriched in deuterium and of high purity, may be further purified and enriched in deuterium by low-temperature processing at a lower cost than other grades.

▶ **Pre-Enriching Hydrogen** — Initial, electrolytic, deuterium enrichment of hydrogen will take place in Nangal's three-stage water electrolysis plant, supplied to them by Oronzio De Nora, Milan, Italy.

When completed, this largest water electrolysis plant in the world, will supply Nangal's ammonia-synthesis plant with 880,000 cu.-ft./hr. of hydrogen. Hydrogen-distillation plant will borrow 180,000 cu. ft./hr. of deuterium-enriched hydrogen from electrolysis plant, will return hydrogen to ammonia-synthesis plant after draining it of deuterium.

Deuterium pre-enrichment of

• Process details furnished by D. Gupta, India's Atomic Energy Establishment; W. Lehmer and W. Baldus, Gesellschaft für Linde's Eismaschen A. G., Höllriegelskreuth bei München; W. J. Maguire, Vitro Eng. Co.



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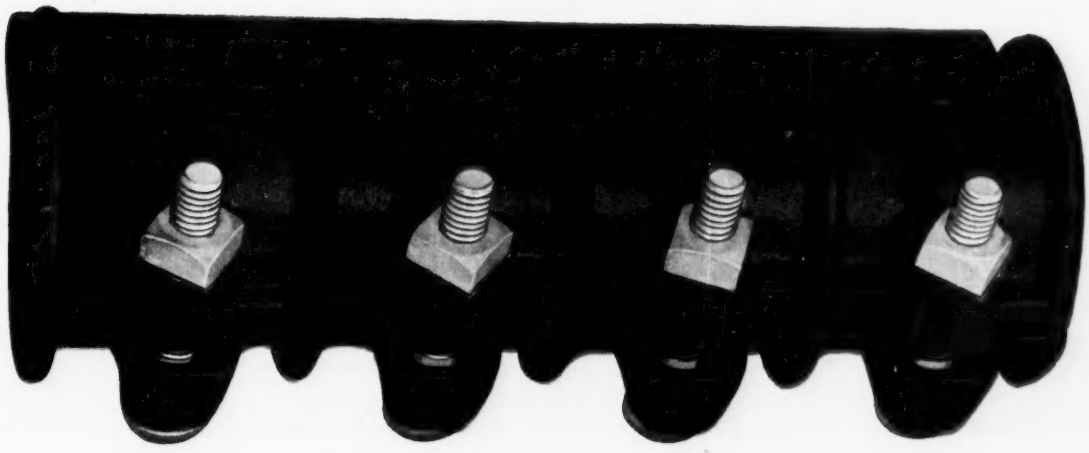

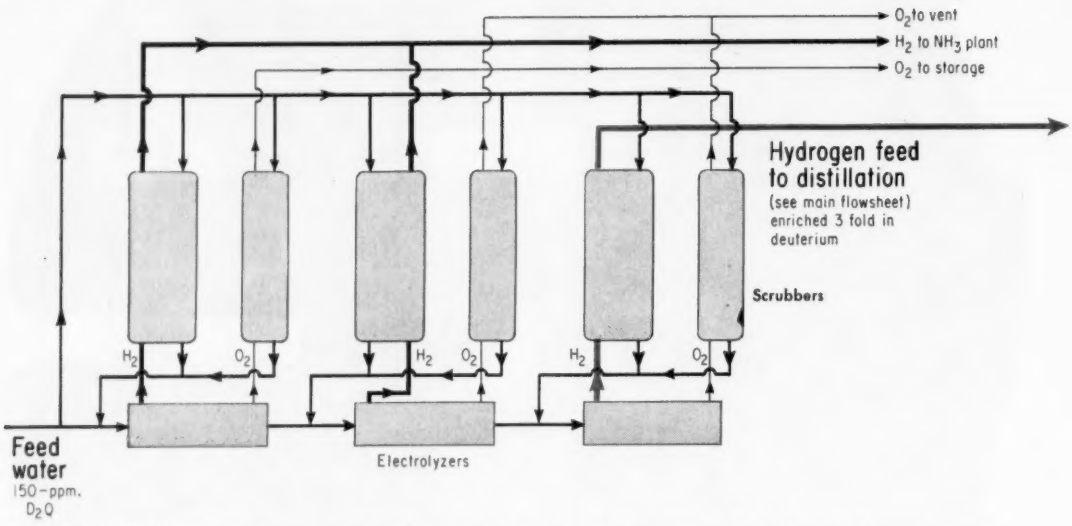

ELECTROLYSIS: **World's largest water electrolysis plant in India will enrich hydrogen for heavy water.**

hydrogen results from three-stage arrangement of electrolyzers. In first two stages, water only partially electrolyzes; overflow goes on to consecutive stages.

Since natural water (H_2O) electrolyzes more readily than heavy water (D_2O), feed stream to final stage is thus deuterium-enriched. Final stage cells completely electrolyze their feed stream yielding deuterium-enriched (900-ppm. deuterium) hydrogen and oxygen.

But credit for deuterium-enrichment within the electrolysis plant also goes to a unique scrubber arrangement. Natural water from the Sutlej River scrubs deuterium from electrolytic hydrogen and oxygen streams in counterflow scrubbing columns before feeding the cells.

▶ **Impurities Get Cold Shoulder** —Compressor pressurizes deuterium-enriched hydrogen from the electrolysis plant to 5 atm. Deoxo unit reduces oxygen content from 0.2% to less than 1 ppm.

Bank of regenerative heat-exchangers cools gas to −157 F., thus freezes out any water vapor present. Following pair of regenerative heat exchangers cools gas further to condense 0.12 ppm. carbon dioxide present.

Series of heat exchangers, cooled by recycle liquid hydrogen, and one cooled by nitrogen boiling at −343 F., cool hydrogen feed stream to −342 F.

Final set of regenerative heat exchangers cool hydrogen feed to about −413 F., freezing out the 0.1% nitrogen content and any other impurity traces onto regenerator packing.

▶ **Low-Temperature Distillation** —Purified hydrogen feeds primary-distillation column's lower section.

Primary column fractionates feed into a 4%-HD stream and 20-ppm.-HD overhead, is a plate column consisting of three sections. Lower section operates at 3 atm., middle at 2 atm. and upper at 1 atm.

Each column section partially enriches hydrogen stream in HD, thence feeds its HD-enriched product to the middle of the section above it in the column. Primary-column product, tapped from the bottom of the upper section, feeds directly to the top plate of the secondary column for further enrichment to 90% HD.

▶ **Catalytic Conversion** — Heat exchanger, outside the inner insulated enclosure, heats HD-enriched, secondary-column bottoms to ambient temperature. Catalyst-containing reactor converts concentrated HD to an equilibrium mixture of D_2, HD and H_2.

Latter mixture gives up its heat to HD-concentrate being fed to the catalytic reactor, is thus recooled before re-entering insulated inner enclosure. Recooled, deuterium-bearing mixture feeds final distillation column.

Final fractionation results in 99.7%-D_2 bottoms and D_2-HD-mixture overhead, which recycles to primary and secondary columns. Pure oxygen, from second electrolysis stage burns final deuterium product to produce water containing 99.8% deuterium oxide or heavy water.

▶ **Regeneration and Recycle** — Depleted, primary-column overheads first cool lower-section product, reboil and feed hydrogen, then stream through regenerative, nitrogen-deposition heat exchanger in a phased cycle.

In first regenerative cycle, depleted hydrogen evaporates and carries away deposited nitrogen, then similarly regenerates other heat exchangers used to trap water and carbon dioxide.

In second phase, depleted hydrogen, induced through nitrogen-deposition heat exchanger by 0.05 atm. vacuum, assures total removal of nitrogen and other impurities.

In third and final regenerative phase, primary column overheads, flow through nitrogen-deposition heat exchanger to precool it in preparation for purification of hydrogen feed.

▶ **Recooling Recycle** — Third-

KENNEDY Coke-calcining Kilns

Mountaineer Carbon Company achieves higher yields and better quality at their new Cresap, W. Va. coke-calcining plant—with a KENNEDY Kiln and KENNEDY Kiln Accessories.

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Mountaineer averages better than 75% yield, several percentage points higher than older installations. And the coke is more uniform in density.

Mountaineer gains these advantages through close control of combustion. A single gas-fed burner in hood at discharge end of kiln generates a temperature of about 2,500 F. Flame configuration, primary and secondary air flows are all controlled carefully; seals cut leakage of unwanted air.

This close control of combustion allows some burning of cracked gases from coke bed. Yet, it prevents unwanted combustion of carbon which reduces yields in most coke calcining. Too, it produces uniform density in finished product, a direct result of uniform temperature.

Kiln is 180 ft. long and 10.5 ft. in dia. Rotating at about 1 rpm., it retains coke approximately 100 min.

KENNEDY equipment is behind the high performance record of this new plant:

- The 180′ long kiln with its bronze sleeved, self-aligning bearings, 3-tire supports and drive assembly;
- Special feed and discharge air seals which reduce air leakage and improve combustion control;
- The kiln firing hood with its extra large access doors for maintenance;
- The air cooled nose ring assembly, specially designed by KENNEDY for coke-calcining.

When you are in need of kilns—for lime, calcined coke, dead burned dolomite, cement by wet or dry process, nodulizing and agglomerating or drying—consult KENNEDY. You can be assured of quality equipment that delivers high, long-lasting performance.

See pages 419–423 in your Chemical Engineering Catalog for a full listing of Kennedy Products for the Chemical & Process Industries

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phase, recycle hydrogen then cools the incoming compressed hydrogen from recycle compressor before feeding into suction side of compressor. It is there compressed to 100 atm., thence cooled to −40F. by the auxiliary ammonia refrigeration system, and finally to −342F. by nitrogen evaporative coolers.

Nitrogen absorber removes traces of nitrogen picked up during regeneration of nitrogen-deposition heat exchanger. Cold regenerators cool it down to −393 F. Stream then expands to reboiler pressure; resulting liquid hydrogen supplies primary column with reflux while remaining gas phase feeds reboilers of all three distillation columns.

Auxiliary ammonia-refrigeration system and nitrogen boilers provide refrigeration that keeps the distillation plant in operation. Liquid nitrogen will be provided by Nangal's adjoining air-liquefaction plant.

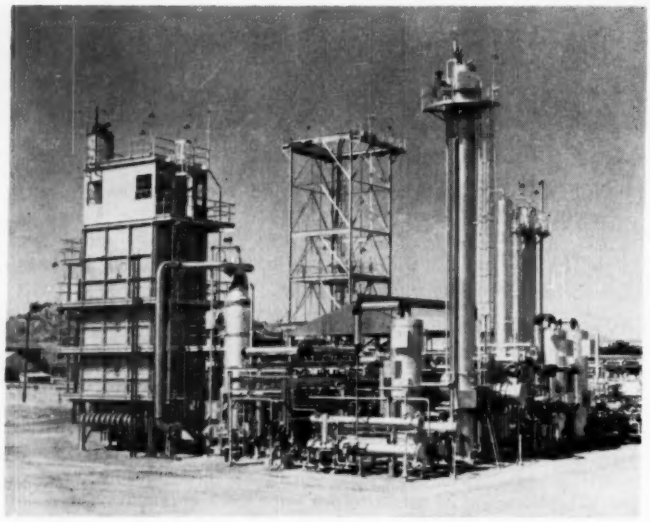
Smog Make You Cry? Ford Has an Answer

Los Angeles' acute smog problem, which recently prompted the Board of Supervisors to restrict the burning of fuel oil (*Chem. Eng.*, Dec. 15, 1958, p. 65), may be alleviated through research going on at the Ford Motor Co. at Dearborn, Mich.

Ford researchers have developed a catalytic converter that can be incorporated into automobile mufflers to eliminate 60 to 73% of the exhaust hydrocarbons that are believed to aggravate Los Angeles' smog woes. Estimated installed cost of the converter (which uses a vanadium pentoxide catalyst) would be $150, but Ford points out that it does not make the mufflers it installs in its cars.

Converter, similar in appearance to a standard muffler, holds 25-30 lb. of ⅛-in. dia. catalyst pellets coated with vanadium pentoxide. Catalyst life is estimated to be 10,000-12,000 miles—about one year's average driving. Adding to the original cost of the converter is the need for introducing air into the chamber to assure an oxidizing atmosphere.

In smog chamber tests at Stanford Research Institute, the converter system reduced level of eye irritation in automobile exhausts from "severe" to "none."



Ammonia Plant Is Smallest Such Unit in U. S.

Said to be the smallest integrated ammonia plant in the country, this 30-ton/day unit was built by Girdler Construction Div. of Chemetron Corp. for Apache Powder Co., at Curtiss, Ariz. It's been on stream since May 1958 at 100% load factor.

The plant uses a hydrocarbon reforming process with natural gas as raw material. Investment cost per ton of output is higher, according to Girdler, than larger plants, but direct production costs are competitive with conventional plants of 100-ton/day capacity or higher.

Ocean Transport Costs For Natural Gas Revised

At the recent International Convention on Hydrocarbons in Piacenza, Italy, one natural-gas expert came up with some interesting revised costs for liquefaction and ocean transport of natural gas.

Here are brief items of top interest, taken from a paper by Air Products Inc.'s Lajos Von Szeszich*:

For investment costs of natural gas liquefaction plants, Szeszich gives figures of $300-$400/Mscfd. capacity, versus $196-$242 given in the literature. Figures are for a plant which receives natural gas at 600 psig. and reliquefies boil-off from storage.

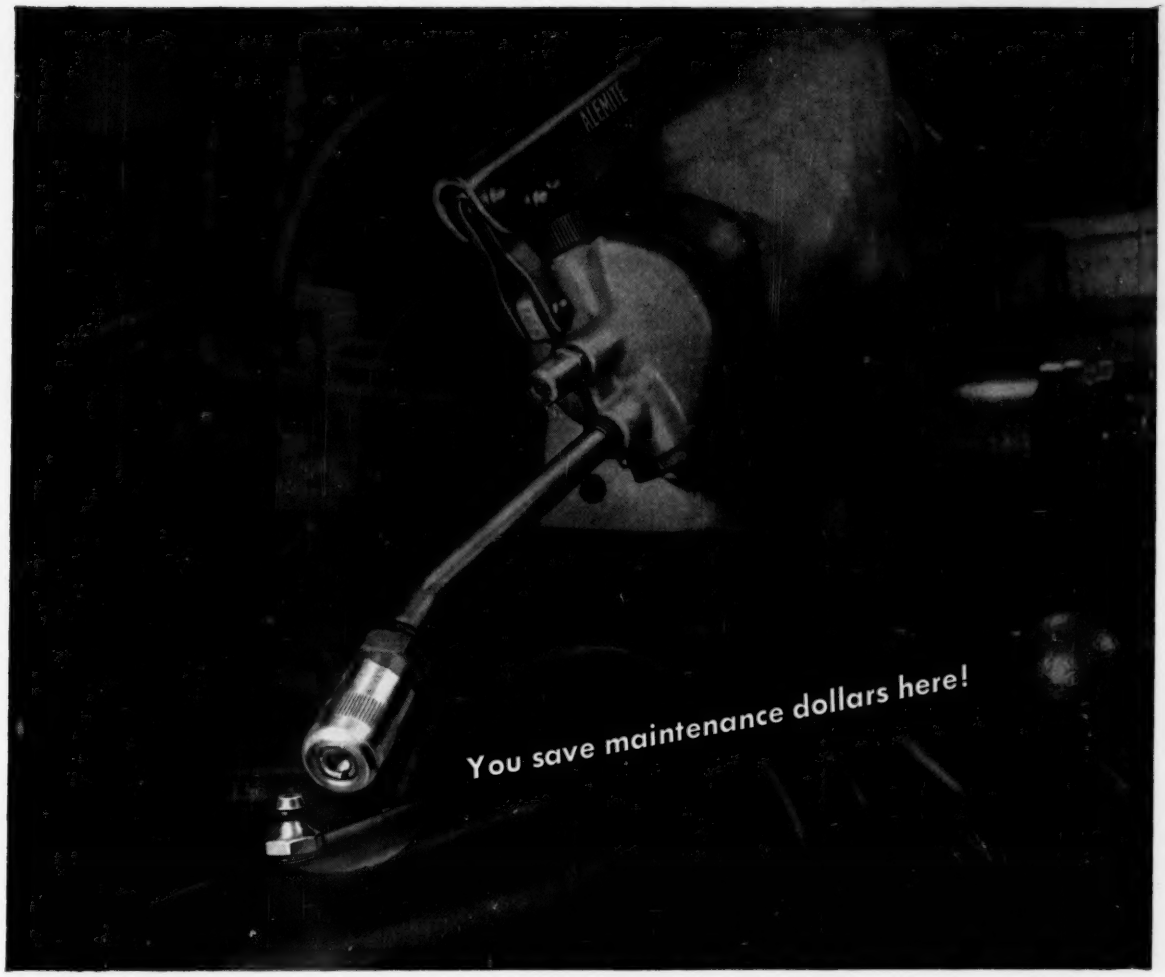
Liquefied gas storage costs: $6-$17/Mscf., for single-tank storage volumes of not less than about 19,000 cu. ft.

Plant operating costs: 8.5¢-10.5¢/Mscf., including storage and loading costs but not raw-material or fuel costs, depreciation or return on investment.

Ships built in non-American shipyards: $700-$850/ton of methane carrying capacity, for ships of 10,000-25,000-ton carrying capacity.

Parallel costs for propane, butane and LPG are considerably lower.

* Figures are for cascade-cycle plant, and assume 30% efficiency for power generation, fuel requirements of 15.8% of the methane liquefied.



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There're awards for everything . . . but only one to chemical engineering achievement through management-engineer teamwork in industry. Here's your chance to help select winner for 1959

Pick Top Team in Engineering Achievement

What company has done most in the last three years to advance the practice of chemical engineering in industry and to encourage its chemical engineers to participate in *all* the affairs of the industry and the profession?

As chemical engineers, you have a vital interest in the answer . . . in this unique recognition of the management-engineer teamwork that means so much to chemical engineers everywhere.

As chemical engineers, you also have the opportunity to help select this year's winner . . . to cooperate in a project that will reflect the most meritorious contributions to the advance of the industry and the profession made since 1956.

All you have to do is to send your nomination to the secretary of the Award Committee before April 15, 1959. Your nomination will then be forwarded to the committee of 94 senior chemical engineering educators (see p. 76) serving under the chairmanship of Walter G. Whitman of MIT.

This committee will name the recipient of the 15th Biennial Award for Chemical Engineering Achievement—an award established in 1933 and sponsored since that date by *Chemical Engineering*. The name of 1959's winner will then be added to the honor roll of previous recipients (see p. 76) whose accomplishments reflect major achievements of the past quarter century.

▶ **For What Purpose?**—Purpose of the Award for Chemical Engineering Achievement is to recognize the results of group effort: teamwork among management, engineering, research, production and sales divisions of a corporate organization. It is awarded to a company, or to a department within a company, rather than to any individual.

This award, therefore, serves the dual purpose of (1) recognizing an outstanding group accomplishment and (2) calling attention to a company in the process industries that has encouraged its chemical engineers to participate in all the affairs of the industry and profession.

▶ **Who's Eligible?** — The 1959 Award for Chemical Engineering Achievement will apply only to industrial developments that have reached commercial fruition or have become known publicly since January 1956. All nominations must be received by the Award Committee's secretary by April 15, 1959.

Subsequent presentations to the committee should (1) describe the nature of the achievement; (2) define the period of its commercial fruition; (3) explain to what extent chemical engineers participated in its development; (4) make available to the committee whatever supplementary records, data, articles or references are available so that it may give fair consideration to the achievement as well as to its company management, engineering, personnel and employment policies.

▶ **Who Will Judge?**—The Committee of Award consists of the heads of chemical engineering in all educational institutions of the U. S. whose courses are now accredited by the American Institute of Chemical Engineers and the Engineers' Council for Professional Development.

W. G. Whitman, chairman of the department of chemical engineering at MIT, is chairman of the Award Committee; Sidney D. Kirkpatrick is vice chairman and John R. Callaham is secretary without vote. Sponsor is *Chemical Engineering* magazine.

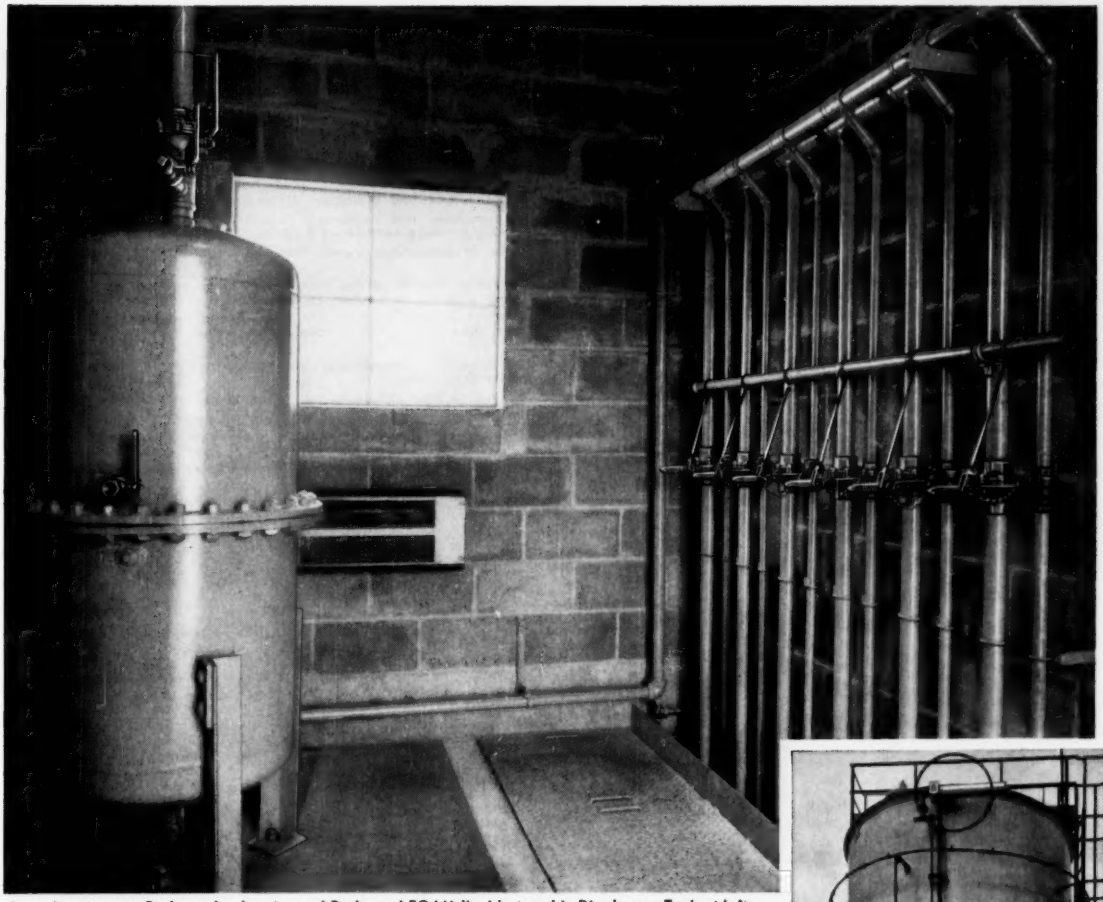
▶ **What and When?**—The award consists of an appropriate bronze plaque embossed to indicate the nature of the achievement and name of company honored.

It will be presented at a formal dinner of the leaders in the nation's chemical engineering profession in New York City on December 1, 1959. This event will highlight the 27th Exposition of the Chemical Industries, the world-famous "Chem Show." Further details will be announced soon in *CE*.

▶ **How You Can Participate**—Nominations for this biennial award will be considered (1) from those companies that file formal application with the Committee, (2) from those individuals from any and all sources, particularly chemical engineers and management men in the chemical process industries, who wish to direct attention to companies and industrial groups that deserve the Committee's consideration.

Send your suggestions and nominations, in confidence, to John R. Callaham, Secretary, Committee of Award, Room 2400, 330 West 42nd St., New York 36, N. Y. We appreciate your help.

Committee, past winners, p. 76



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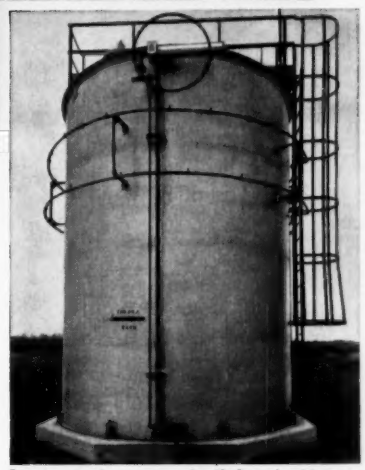

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These Firms Top the List for Chemical Engineering Achievements

See Award story, p. 74

1958	Carbide & Carbon Chemicals Co.	For producing commercially a large number of synthetic organic chemicals from petroleum and natural gas.
1955	E. I. du Pont de Nemours & Co. Organic Chemicals Dept.	For the successful industrial development of neoprene, synthetic camphor and certain other important chemicals and dyestuffs.
1927	Monsanto Chemical Co.	For developing the large-scale production and utilization of elemental phosphorous.
1909	Standard Oil Development Co.	For new chemical engineering processes and equipment to make available super-fuels for aviation, as well as other valuable products synthesized from the hydrocarbons of petroleum.
1941	Dow Chemical Co.	For the recovery from seawater of magnesium metal, then sorely needed for aircraft and munitions.
1943	American Synthetic Rubber Industry	For crowding into 24 months a project that in normal times would have required many years—a miracle of chemical engineering planning and construction. Awarded to 67 companies.
1946	Atomic Bomb Project	For contributing as prime contractors so significantly to the research and engineering responsible for this war-ending achievement. Awarded to 122 companies, universities and research organizations.
1947	Merck & Co.	For successful pioneering in the large-scale production of streptomycin and other vital medicinals and, in a broader sense, for service to humanity.
1948	Shell Development Co.	For the successful synthesis of glycerine from petroleum, for the first time, on a commercial scale.
1949	Celanese Corp. of America	For the outstanding chemical engineering integration of its textile, plastics and chemical operations.
1951	Phillips Petroleum Co.	For pioneering development of high-abrasion carbon blacks, and major contributions to the success of cold rubber.
1952	Carbide & Carbon Chemicals Co.	For the first commercial production of certain aromatic chemicals directly from coal by high-pressure catalytic hydrogenation.
1956	Dow Corning Corp.	For the participation of its chemical engineers in all phases of the successful commercial development of silicone products.
1957	Contributors to Extractive Metallurgy of Atomic Age Metals	For research, development and efficient application of chemical engineering principles and processing in the recovery of metals. Awarded to 77 companies, research and engineering organizations.

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THE PEOPLE WHO KNOW AND CONTROL FLOW

New Carbide Texas Plant Could Make Many Products

Though it will be "some months" before Union Carbide decides exactly what it will make at its newly acquired Brownsville, Tex., plant, the firm has a wide range of products to choose from.

Carbide recently exercised its option to buy the plant and 42-mi. Weslaco-Brownsville natural-gas pipeline from Amoco Chemicals.

The plant was originally built by Carthage Hydrocol in 1950 to make synthetic gasoline (*Chem. Eng.*, Dec. 1957, p. 158). Two 2,000-ton/day oxygen units were then built to make oxygen for partial oxidation of natural gas (Texaco process).

Some of the oxygen could now be used to make acetylene from natural gas; byproduct synthesis gas could be used for ammonia or methanol. Partial oxidation could make hydrogen cyanide. Ammonia and hydrogen cyanide could be used for acrylonitrile. Thus, Carbide could make acetylene, ammonia, methanol, hydrogen cyanide, acrylonitrile or other chemicals.

Tower Does Double Duty In Gas-Phase Reactions

A multi-purpose tower for producing either liquid or gaseous HCl (or hydrobromic acid) is described in a preliminary patent recently issued to the German chemical firm, Badische Anilin- und Soda-Fabrik.

According to the patent (DAS 1,035,626), a complete acid generator can be housed in a single tower. Main claim for the new device is the simple mechanical design which permits use of impervious graphite construction —virtually eliminating all corrosion.

Tower has a bell-shaped converter chamber in the base for the reaction between gaseous hydrogen and chlorine. The HCl gas generated by the reaction escapes through slits in the chamber and passes upward through a packed absorption zone.

Water or dilute HCl is pumped into the top of the absorption zone and contacts the upflowing HCl gas. An increasingly concentrated solution of HCl flows down the tower, cooling both the walls and the reaction chamber.

Bottom of the tower contains a cooler (which can also operate as a heater for producing HCl gas). Liquid acid is tapped off in the collection zone at the base. Another heat exchanger at the top of the tower acts as a reflux condenser.

DTA Unit Tests Reactions On Catalysts and Solids

Differential thermal analysis (DTA) is now being used in Girdler Catalyst laboratories of Chemetron Corp., at Louisville, Ky., to measure catalyst activity and to study adsorption and solid-state reactions.

In operation of DTA, three variables can be controlled: pressure, temperature and composition of the gaseous phase. A reference temperature and differential temperature are recorded. Analyzer compares an active gas's heat of adsorption on catalyst sample with heat of adsorption on a physically similar, but catalytically inert, material. Temperature difference between catalyst and inert material is proportional to the number of active sites on the catalyst and thus to the catalyst activity.

Girdler's technique is to use nitrogen as inert gas with such active gases as water vapor, ammonia and piperidine, depending on catalyst being tested. Test conditions can vary from 1 mm. Hg absolute to 100 psi. and from room temperature to 1,100 C. With these conditions, Girdler can also probe such phase changes as decomposition pressure of most hydrates.

Spray Drying Process Produces Vital Gluten

Switch in production from devitalized gluten to vital gluten (which regains its original vitality or elasticity on being reconstituted with water) has been keyed by a new continuous spray-drying process. New process is now in operation at Midwest Solvents Co., Atchison, Kan.

A development of Buflovak Equipment Div., Blaw-Knox, process is the first successful spray-drying application in the gluten field. It turns out a final product with the same texture as flour; thus, there's no need for grinding with its inherent danger of quality deterioration.

Process involves a special aqueous dispersion technique, using an agent that disappears during spray drying and leaves a resulting powder with no foreign odors, tastes or contaminating substances.

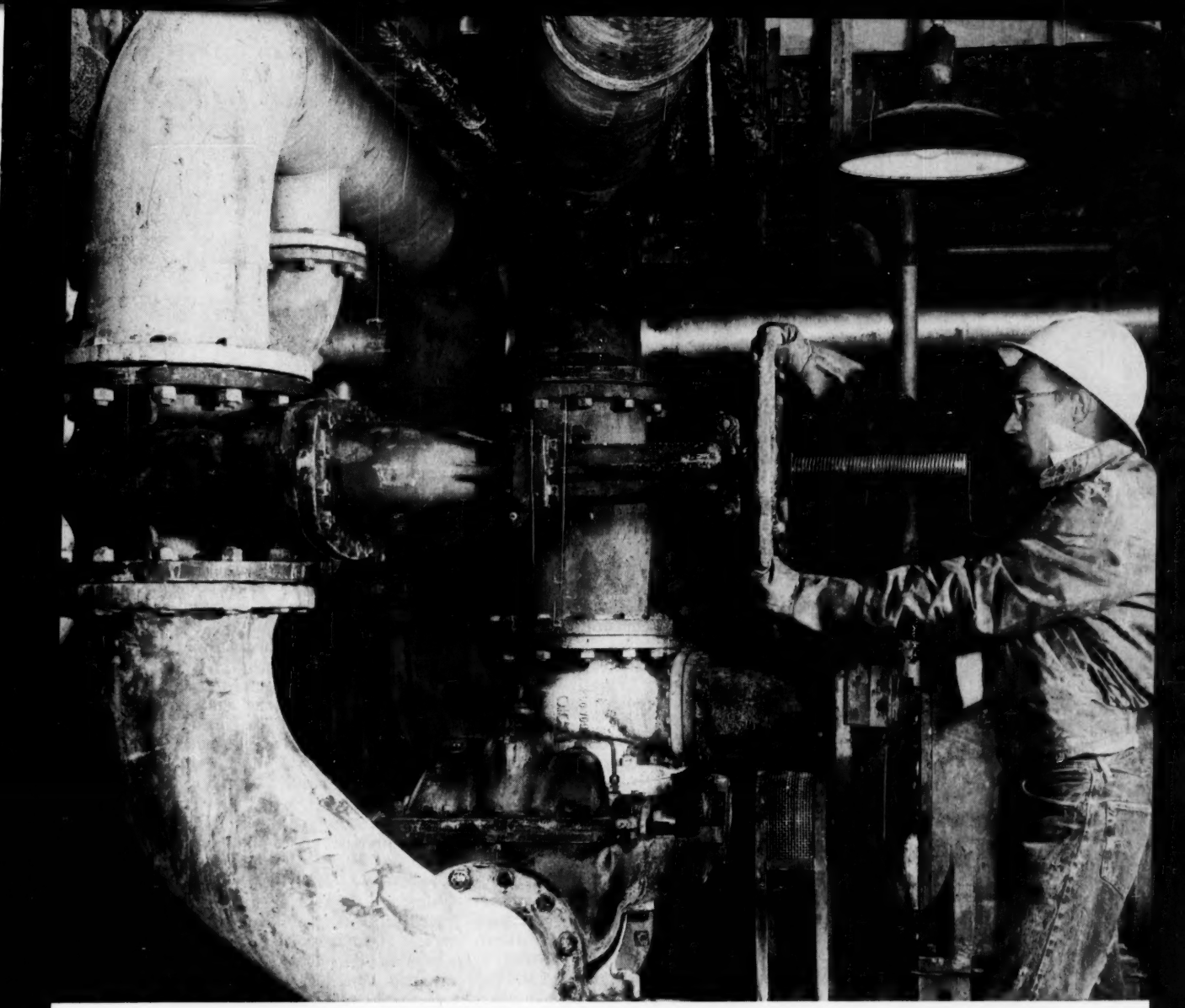
NEWS BRIEFS

Chlorinated hydrocarbons: The American Chemical Corp. will build a $7.5-million plant at Watson, Calif., to make ethyl chloride, ethylene dichloride, vinyl chloride monomer, perchlorethylene, trichlorethylene, polymers and copolymers.

Gas-turbine engine: Chrysler Corp. has developed a gas-turbine engine which is claimed to have as good or better fuel economy than today's passenger-car piston engines. In recent 1,200-mi. economy run, 1959 Plymouth with gas-turbine engine averaged 17-20 mi./gal. compared with 13-14 mi./gal. obtained in similar test run two years ago.

Polyvinyl alcohol: Borden Chemical Co. is building a $1.5-million polyvinyl alcohol plant at Leominster, Mass., adjoining the company's present PVA plant. Second plant, using a new continuous process, will be on stream in October and will turn out 5 million lb./yr. of PVA.

Nuclear propulsion nozzle: Rocketdyne, division of North American Aviation, has delivered propulsion nozzle for Kiwi-A test reactor to Atomic Energy Commission's Nevada test site. Kiwi-A is first reactor designed to study feasibility of nuclear rocket propulsion.



This 4000 gpm Stainless Steel pump has circulated acidic water for four years. It has needed no maintenance.

Stainless Steel equipment cuts replacement costs 75%

AT INTERMOUNTAIN CHEMICAL COMPANY, WESTVACO, WYOMING
operated by WESTVACO CHLOR-ALKALI DIVISION, FOOD MACHINERY & CHEMICAL CORP., NEW YORK

"Hot alkaline crystal slurry ruined our 10,000 gpm pumps after only two years of service," says Mr. Reinert Kvidahl, Operating Superintendent at Intermountain's soda ash plant. "These pumps corroded and leaked. We replaced them with Stainless Steel pumps three years ago, and today they're still in excellent condition. They show no wear at all and no corrosion.

"We also had a 4000 gpm pump that moved acidic water. It needed major repairs in only six months. We replaced it with a Stainless Steel pump that has been in service for four years now and has never needed maintenance.

"Carbon dioxide and other acidic vapors corroded our barometric condensers. We replaced them with Stainless Steel condensers and we've had no more trouble.

"There are many such cases all through this plant. Wherever we had corrosion maintenance problems, we have replaced equipment with Stainless Steel—in pipes, valves, flex joints, filter leaves, linings, even nails and bolts. Because the Stainless resists corrosion and lasts years longer, we've saved more than 75% in replacement costs in spite of the higher initial cost of the Stainless."

End corrosion losses and frequent replacements in *your* plant. Replace with Stainless Steel. And specify USS Stainless Steel for service-tested quality.

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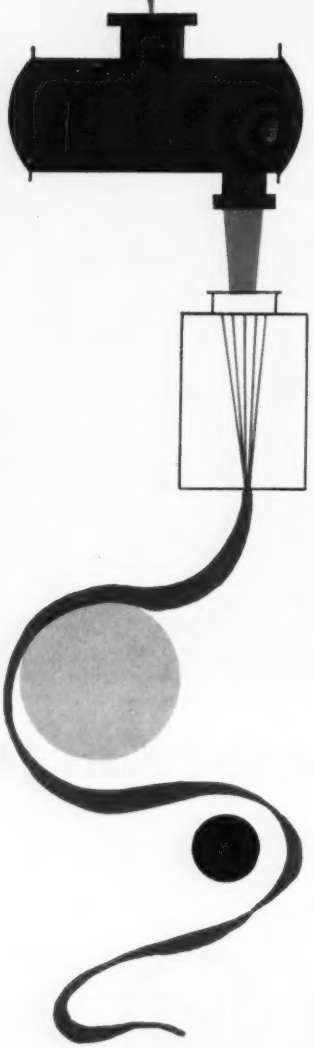
United States Steel Supply—Steel Service Centers
United States Steel Export Company

United States Steel

Pigments

Textiles Beckon to Pigments



Spun-dyed synthetic fibers and printed cloth will help textiles become pigments' fastest-growing end use.

"The consumption of pigments in textiles bears close watching during the next five years." So states the most significant observation in a pigment survey carried in a recent edition of Stanford Research Institute's Chemical Economics Handbook Newsletter.

The report sees an opportunity for pigments to really catch hold in two areas of textile processing:

Spin Dyeing—The proliferating family of synthetic fibers poses a very lucrative market for textile pigments by virtue of a manufacturing technique common to all its members: extrusion of a polymer melt or solution thru spinnerets into a coagulation-spinning chamber. Addition of extremely fine particles to the fiber liquid makeup prior to coagulation results in internal pigmentation of the finished fibers (a pigmentation which otherwise may be impossible or difficult to obtain).

Cloth Printing—"Of all their end uses," reports the SRI newsletter, "pigments have surged fastest in textile printing, a field formerly dominated by dyes." Key to success: special resins which can bond insoluble colored pigments to cloth.

Spun-dyed viscose rayon fibers have been produced. And acetate rayon makers find spin dyeing upgrades their material by improving color washfastness.

Du Pont has marketed limited quantities of spun-dyed nylon, and manufacturers of the newer synthetics are considering use of this coloring technique.

▶ **Acetate Rayon Market**—Some experts, according to the newsletter survey, predict that 30% of all acetate rayon will eventually be spun-dyed, although less optimistic predictions are coming from viscose rayon producers.

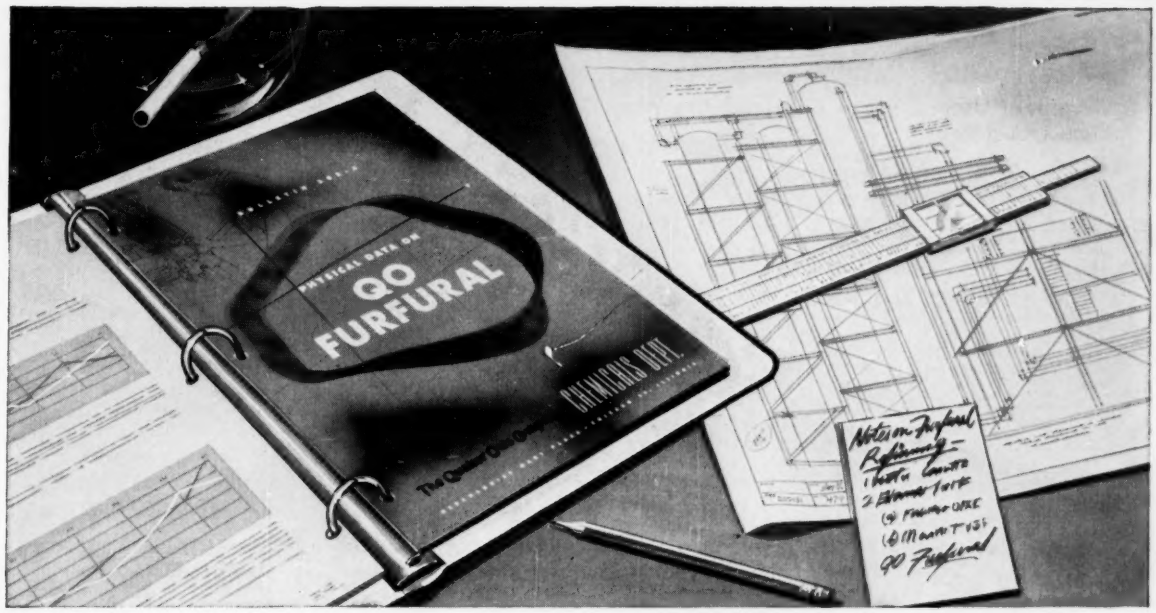
Crocking (lack of rubbing fastness) and inferior washfastness are two serious problems barring a real breakthrough for pigments in textile printing. If these problems are solved, however, "the lower cost of the pigment-resin method of textile printing may prove a serious threat to dyes."

▶ **Other Pigment End-Uses** — The SRI report sees little likelihood of outstanding growth in other pigment end uses. Surface coatings—paints, varnishes, and lacquers—should remain the top pigment consumer for some time. Printing inks and paper, which rank right behind surface coatings as pigment users, have consumed increasing quantities of pigments in recent years. They figure to grow some more, although they're not likely to overtake the surface coatings category.

Rubber and floor coverings (which include linoleum and felt-base coverings, but not plastics) show no signs of spectacular growth. (We exclude carbon black, used as a reinforcing agent in rubber, and zinc oxide, which is used primarily as an activator of organic accelerators in vulcanization.)

▶ **Little Bit of a Lot**—Pigment use in plastics will not increase much, despite the tremendous growth of plastics, because of the very small quantities of pigment required to color resins.

Any increase in ceramics consumption of pigments will stem from expected growth in the



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These are some of the reasons leading companies have included QO furfural in their plans. Get facts for your planning by writing for Bulletin 203-A entitled "Physical Data on QO Furfural."

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Pigment Uses: Surface Coatings Are Way Out in Front

(Million Pounds, 1956)

Type	Surface Coatings	Printing Inks	Paper	Ceramics	Textiles	Floor Coverings	Rubber	Plastics	Misc.	Total
Colored	158.2	82.6	12.0		34.0	12.0	9.0			363.6
White	609.8	25.3	115.0		55.2	46.0	40.0			1,225.2
Black	17.9	38.4	0.5							92.0
Total	785.9	146.3	127.5	40.4	89.2	58.0	49.0	6.9	377.6	1,680.8

Source: Stanford Research Institute

Colored Inorganic Pigment Production

(Million Pounds)

	SYNTHETIC					NATURAL		TOTAL
	Chromate	Ferrocyanide	Mixed Chromate & Ferrocyanide	Sulfide & Sulfoselenide	Hydrous Oxide & Oxide	Iron Oxide	Other	
1953	59.4	10.0	14.8	4.0	121.6	107.8	2.6	320.2
1954	58.6	9.2	13.2	3.4	135.2	61.6	8.0	289.2
1955	66.6	10.2	13.2	4.2	161.8	74.2	7.4	337.6
1956	63.8	10.8	10.4	4.0	151.6	74.4	7.4	322.4
1957	60.6	9.8	9.2	3.2	147.8	62.6	7.0	300.2

Source: Bureau of the Census; Bureau of Mines

Colored Organic Pigment Production

(Million Pounds)

	AZO			NON-AZO				OTHER	TOTAL
				Condensation					
	Soluble	Insoluble	Other	Basic	Acid	Phthalocyanine	Other		
1953	10.3	9.6	0.4	3.3	4.5	3.8	1.7	10.3	43.9
1954	10.4	11.1	1.5	3.7	4.1	5.3	1.4	2.2	39.7
1955	11.1	11.2	1.4	3.7	4.8	7.4	1.4	3.4	44.4
1956	10.5	10.8	1.3	3.3	5.1	5.5	1.4	3.0	40.9
1957	9.5	10.1	1.3	2.8	4.4	6.3	1.0	2.2	37.6

Source: U. S. Tariff Commission; Stanford Research Institute

use of architectural porcelain enamel.

Surface Coatings — White opaque pigments, which satisfy better than 75% of the demand for pigments in surface coatings, are the most important single group of pigments because of the predominance of white as a color and the need for it in many tints and light colors. The trend in the auto industry toward lighter pastel color shades has called for increasing consumption of white pigments in automobile paints. And as colors become lighter, the need increases for greater TiO_2 content to provide better heat stability of colors in multitone work.

▶ **Worth the Extra Cost**—More expensive organic pigments have become increasingly important in the race to find bright, lightfast colors for exposure to sun and weather. Phthalocyanine blue and green pigments prove ideal for coatings in which overall light fastness is an all-important requirement.

Inks — Color packaging, currently growing at a rate of $2 billion/yr., is sparking the use of printing inks and the pigments consumed in those inks. Color advertising—50% of all magazine advertisements now use color—is another factor in pigment-use growth. Some of the large volume pigments used by the printing ink industry: lithol reds, eosine reds, peacock blues (organic) and chrome yellows. There seems to be a trend toward phthalocyanines and other relatively high-cost, high-quality pigments.

Paper — Principal pigment uses for paper are in coatings which control opacity, gloss and ink receptivity. Color printing

Symbolized here is the uncontrolled (multi-point and premature) surface ignition on hot engine deposits that results in abnormal pressure rise and engine noise in some high-compression automobile engines. Driving conditions breed a problem too. Start-and-stop driving that builds excessive deposits is prime offender.

ATTACK ON A NEW KIND OF ENGINE KNOCK...

Celanese compounds modify engine deposits, improve combustion, reduce noise

Two great industries face a real problem in uncontrolled combustion—which results in a rumbling vibration in the higher compression engines of some of today's automobiles. This new kind of engine knock not only disturbs car owners — it puts limits on compression ratios, gasoline composition, and potential engine efficiency.

Among fuel additives researched to combat abnormal combustion, only the organo-phosphorus compounds have been able to help; they modify the composition of hot engine deposits, thus control surface ignition, and reduce excessive pressure and engine "screaming."

Since the first phosphorus additives were introduced into motor fuels a few years ago, Celanese has been a leading supplier to a growing number of gasoline refiners. And indeed, phosphates — which we have been producing for 35 years—are only one member of a huge family of Celanese chemicals basic not only to the automotive and petroleum industries but to scores of others as well.

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Automotive	Pharmaceutical
Aviation	Plastics
Building	Surface Coating
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favors TiO_2-coated paper to achieve brilliance.

Value of titanium dioxide pigment used in paper increased from $10 million in 1950 to $28.7 million in 1956. Further increases may result from a trend —stimulated by increased postal rates — toward lighter-weight papers which require opaque coatings.

Clay fillers, which have been doing most of this opacifying job, may have reached the limit of their effectiveness. And since TiO_2 has greatest hiding power of all white pigments, less pigment is required for better opacity, thus permitting further reduction in the paper's thickness.

Ceramics—Percentage of porcelain enamel frit going into architectural porcelain enamel—curtain walls, window walls and panels—in 1957 was double that in 1956. Expected construction surge in the next couple of years should carry pigment use to new heights in this category.

Some pigments commonly used in ceramics and glass: chromium oxide, iron oxide, titanium oxide and cadmium sulfoselenide. Titanium dioxide is most widely used pigment for making enamels opaque.

Floor Coverings — Pigments used in linoleum are about the same as those used in surface coatings, titanium dioxide being the most important. In 1956, 40 million lb. was consumed. Among colored pigments, there is a definite trend to brighter and more stable pigments.

Rubber—TiO_2 is well-suited to producing light-colored rubber goods, again because of unequaled opacity, high total brightness and small particle size. (It made up 96% of all white pigments—in terms of value — used in rubber for color and color-related purposes.) Color pigments for rubber are generally organic because they produce, in smaller quantities, the same color quality as inorganic pigments.

Plastics — Pigments comprise only about 0.5% of the combined weight of resins, fillers and plasticizers. Pigments are added to the resin in the manufacturing or fabrication stage depending on the composition of the industry, the desired end-use, etc.

Nuclear Energy: At Best, Good for Only 25% of Our Needs

Energy Outlet	% of All Energy In 2000 A.D.	Nuclear Energy's Share . . . of Energy Outlet, %	Nuclear Energy's Share . . . of All Energy, %
Electric power	23	80	18.4
Industrial, process heat	24	15	3.6
Residential, commercial heat	25	10	2.5
Maritime and Navy	2	50	1.0
Highway and aircraft	20	—	—
Railroads	1	—	—
Non-fuel and losses	5	—	—
Total	100		25.5

Nuclear Energy:

It Can't Supply All Our Needs

Don't count on nuclear power assuming more than perhaps one-quarter of our future energy burden. Its limitation: an inherent inflexibility.

Nuclear energy's potential is definitely limited. Assume the reserves of fissionable material are enormous (which they are). Assume economic delivery of nuclear energy (which is less than ten years away). Its potential is still limited.

Nuclear energy is penalized by its fuel, which must be recycled and reprocessed for economic utilization, and by its radioactivity, which must be contained by heavy, bulky material.

These two characteristics alone, particularly the latter, would seem to exclude nuclear energy from extensive use in the foreseeable future for many applications—e.g., small and portable energy sources like the engines in automobiles, trucks, buses, small boats, small planes, and trains.

"Thus, we can see," says Kenneth Davis, vice president of Bechtel Corp., "that at most we can anticipate only about 25% of our total energy requirements coming from nuclear power even after it is fully developed and economically competitive. Nuclear energy cannot by itself satisfy the ever-increasing demands for energy and is not the answer that will be so badly needed by a country and a world running out of fuel resources in another 50 to 75 years."*

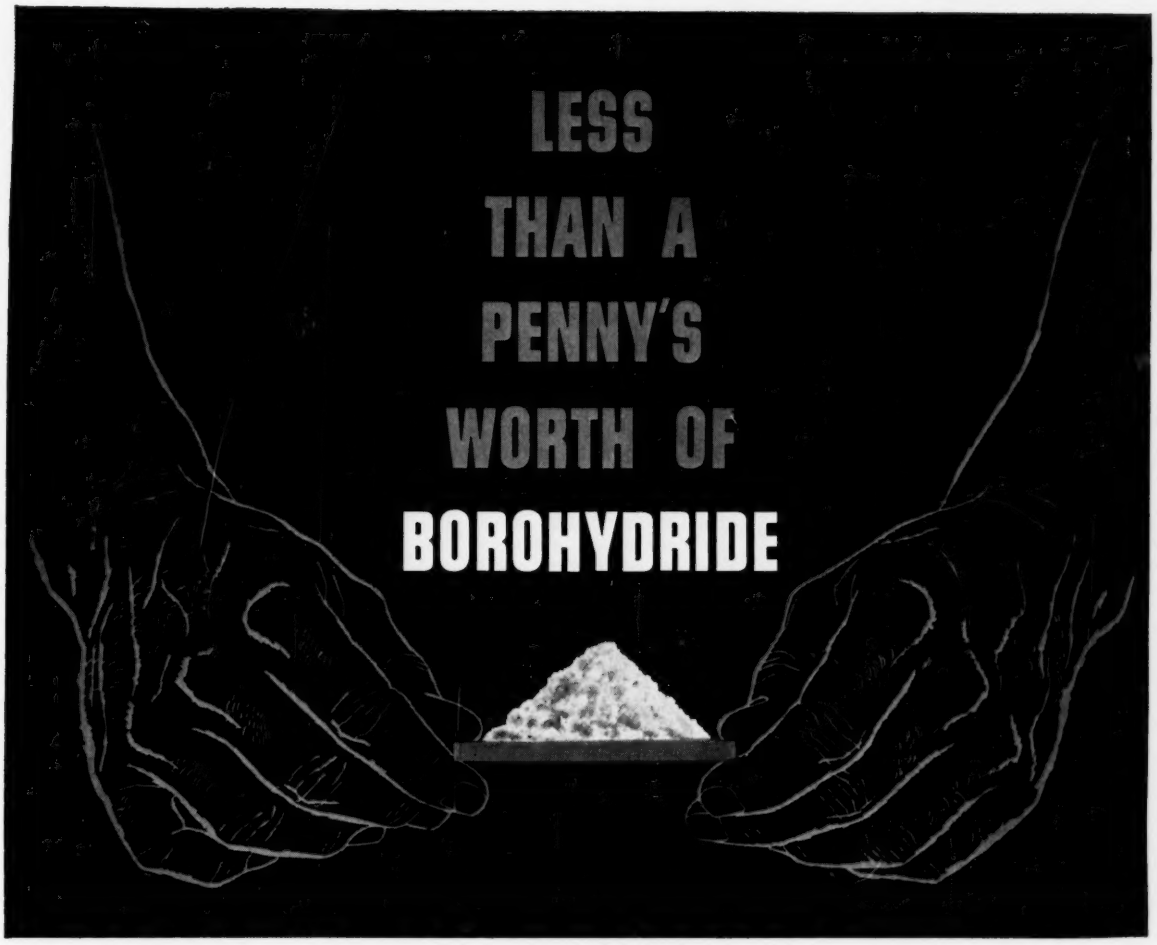
▶ **Limits on Fusion, Too**—But how about fusion — thermonuclear power? This, too, says Davis, has "serious limitations which prevent its direct use (even when fully developed) for meeting the larger proportion of foreseeable energy requirements."

One of the consequences of nuclear energy's inability to be the answer to all our needs, or even close to all our needs: "It is desirable now and will later become necessary to conserve reserves of conventional fuels not only for nonfuel uses such as lubricants, chemicals and plastics, etc., but also for the many specialized energy applications which can only be reasonably met with conventional fuels."

Another consequence: " . . . we are now at a point in time where plants using conventional fuels being started today may have a problem in obtaining fuel at reasonable prices toward the end of their useful lives."

▶ **How We Can Help**—Here are

* From Mr. Davis' AIChE Professional Progress Award Lecture, "Energy Engineering."



will "clean up" unwanted aldehydes, ketones, peroxides from a pound of product!

Now, with either MHI sodium borohydride or potassium borohydride it is possible to "clean up" minor amounts (0.5% or less) of these unwanted contaminants effectively by simple contact methods.

This will be especially welcome news if you are now faced with the difficult problem of catalytic hydrogenation, distillation, or complicated chemical treatment to remove residual aldehydes, ketones or peroxides from your product. This is of especial importance if you must maintain color stability in your organic products, if you are concerned with carbonyl poisons in organo-metallic polymerization systems, or if you wish to reduce and inhibit peroxides in ethers. The easy borohydride method adds less than a penny a pound to the material cost of your product and may save more than that in processing costs!

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- PENTAERYTHRITOL
- PEROXIDE CATALYZED POLYMERS
- CELLULOSE PULPS
- PEROXIDE BLEACHED ORGANIC MATERIALS *(waxes, etc.)*
- CHLORINATED HYDROCARBONS
- OXIDIZED HYDROCARBON STREAMS
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some mitigating possibilities, developments to work towards which Davis feels could broaden nuclear power's area of usefulness:

- More compact and lighter reactors which are sufficiently safe and cheap.
- Better methods of storing thermal or electrical energy for use in mobile applications and in many specialized uses.
- Methods of energy utilization which permit greater use of electric power or heat from large central units.

"The problem then is not that nuclear power is not a useful new source of energy with vast resources (its quarter share in 2000 A.D. will be equal to *all* the energy consumed in the U. S. today) but that it is not available in a form which permits general use for meeting all energy needs."

▶ **Energy - Outlet Rundown** — The table on p. 84 shows how Davis arrived at his sobering estimate of nuclear energy's 25% share of the total U. S. energy supply in 2000 A.D. Let's examine now the thinking that went into his individual estimates.

Electric Power Generation—This is a natural field for nuclear energy, becoming more and more attractive as central generating stations become larger and costs of nuclear power come down. Economic nuclear power plants may be operating within ten years in the U. S., within five years in industrialized countries abroad. Give nuclear energy credit for supplying 80% of domestic requirements for electric power by 2000 A.D.

Industrial and Process Heat—Certain plants and manufacturing units may demand enough energy to justify profitable nuclear power participation. In most cases, though, the energy needed in one place is of such a small amount or in so specialized a form that nuclear energy is not apt to be used. Give nuclear energy credit for no more than 15% of this energy market in 2000 A.D.

Residential and Commercial Heating—Most of the energy demand here arises from a vast number of very small heating units with low over-all use factors. These are relatively unsuited for satisfactory application of nuclear power. However, nuclear energy will find a spot in this area through the emergence here and there of large central heating plants and the increasing popularity of heat pumps which make space heating dependent upon electrical energy. Give nuclear energy 10% of this total residential and commercial heating market in 2000 A.D.

Maritime and Navy — This field, along with electric power generation, appears to be vulnerable to deep penetration by nuclear energy. Most naval ships will eventually be nuclear powered, so compelling are the advantages. Nuclear propulsion will prove economic for other vessels of appreciable size and use factor. Give nuclear energy 50% of ship-propulsion requirements by 2000 A.D.

Highway—Nuclear energy is "completely unsuited" to supplying the enormous total requirements of myriad small internal combustion engines used for propulsion of automobiles, trucks, buses, outboard motors, small boats, small planes. Nuclear reactors seem too large, heavy and hazardous to be feasible. (Conceivably, nuclear fission could supply the energy to produce synthetic fuels for use in these small engines.)

Railroads — Relatively small size of railroad power plants and cheapness of conventional fuel consumed make significant utilization of nuclear power very questionable in this area. Indirect propulsion via electric power seems the more logical nuclear role.

Aircraft — Nuclear power is unsuited for aircraft in cargo or passenger service for the same reasons it is unsuited for highway vehicles: size, weight, hazard. Military aircraft may be an exception. In spacecraft, civilian or military, nuclear power appears to be "an absolute necessity" despite its drawbacks, although the future of spacecraft in our over-all energy picture in 2000 A.D. is, of course, a matter for pure conjecture.

▶ **Fresh Water From Salt** — Davis moves on to mention one potentially large use for nuclear energy which has no domestic counterpart in energy use today —production of fresh water from sea water or brackish water. We can expect, says Davis, the establishment of fresh water plants in several areas of the world—with nuclear power as the source of energy.

Now what about controlled fusion, thermonuclear power? Can it fill the energy void of the future? Even assuming that technical and economic problems are surmounted—and these seem to grow more insurmountable day by day—"it is likely that controlled thermonuclear reaction will have many of the limiting characteristics of fission reaction."

Thermonuclear reactors will be huge in size and output (even less portable, perhaps, than fission reactors). They present lesser radioactivity problems but greater neutron-shielding problems.

▶ **Solar Energy the Answer?**—Then what about direct utilization of solar energy? Space heating in some areas seems a good bet. Special cultivation—on sea and land—of "crops" for energy and for food is a possibility. "But it is most difficult to visualize ways in which solar energy could provide directly for many of the uses which are difficult for nuclear energy."

What's the answer then? It lies in the hands of the specialist in the application of energy—the engineer.

Caffeine Imports Keep Monsanto Awake at Night

Monsanto Chemical's caffeine problems are import problems. Repeated tariff reductions on foreign imports of the drug have virtually halved the company's caffeine sales over the past few years, according to Charles H. Sommer, Monsanto vice president.

Monsanto's latest move in the battle with imported caffeine for domestic markets is a 40¢/lb. price cut (to $2.10), the third major price reduction for this drug in the last four years. At $2.10/lb., Monsanto's caffeine is now selling at its lowest level in 25 years.

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it doesn't have
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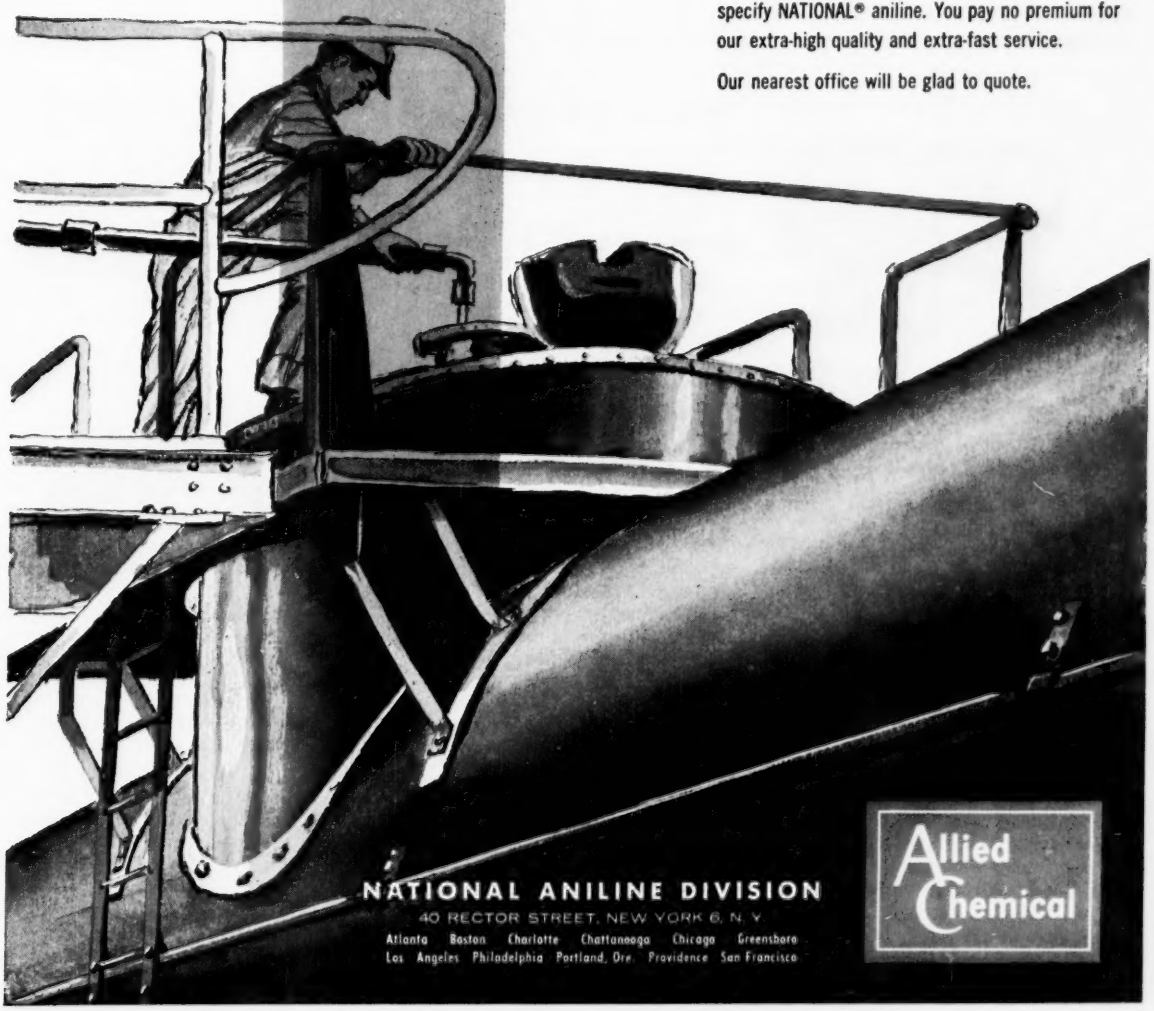
So if you want clear, colorless, nearly dry, high-purity aniline shipped by tank car or tank wagon from Moundsville, West Virginia, on 24-hour notice, specify NATIONAL® aniline. You pay no premium for our extra-high quality and extra-fast service.

Our nearest office will be glad to quote.



NATIONAL ANILINE DIVISION
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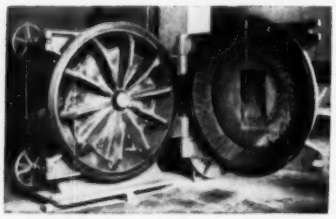
Allied Chemical

DEVELOPMENTS . . .

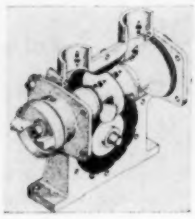
PROCESS EQUIPMENT

EDITED BY C. C. VAN SOYE

Latest Developments

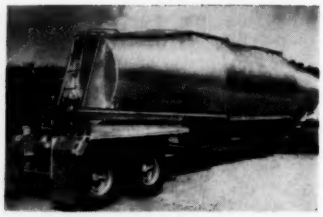


Grinding Mill
German line of high-speed grinders combines principles of hammer and disk mills. *92C*



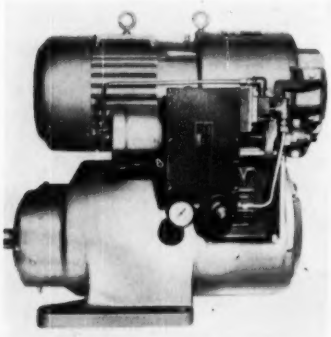
Pump
Positive-displacement unit makes American debut. *182B*

Pipe Insulation
Features ease of installation. Made of Foamglas. *90A*



Bulk Trailers
Two new transports for bulk materials enable bigger, more profitable payloads. *90D*

Page number is also Reader Service Code Number



Drive Control

Pneumatic control varies drive speed.

Designed to replace the handwheels on Vari-Speed Motodrives, a pneumatic control called Airtrol can provide automatic, linear speed changes over a 10:1 range. Lowest output speed for an Airtrol-drive combination is 2 rpm.; highest is 4,660 rpm.

When the drive motor is not operating, a solenoid valve automatically shuts off the main air supply. When reactivated, the device resumes its previous speed. Airtrol is sensitive to changes from 3 to 15 psi. — **Reeves Pulley Co., Div. Reliance Electric and Engineering Co., Columbus, Ind.** 88A

Hopper Car

Offers freedom from contamination; cleans easily.

Named the Dry-Flo, a new covered hopper car empties through either vacuum or pressure pneumatic handling systems, by gravity feed into hoppers below the track, or via any mechanical conveying system. Unloading gates are located completely within the car, thus eliminating pickup of foreign materials, and other problems associated with external gates. Lined interiors are optional.

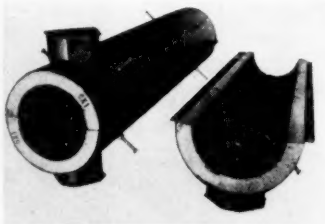
Dry-Flo cars come in two sizes—3,500 cu. ft., and 2,450 cu. ft. Both sizes are available with either single or multiple compartments, and with either 50- or 70-ton trucks.—**General American Transportation Corp., Chicago, Ill.** 88B

Screw Feeder

Bolts to the base of customer's hopper.

Delivery rates from a new line of bulk feeders that can be bolted to the hoppers of storage bins for granular materials vary from 0 to 3,000 cu. ft./hr. Each feeder consists of a totally enclosed motor, a reducer, drive, guard, screw, and housing with flanged inlet and outlet.

Material of construction can be either Type 304 or carbon steel. A variable-speed drive is optional if feed rate is critical or must be varied.—**M-H Standard, Jersey City, N. J.** 88C



Pipe Heater

Keeps high-melting process fluids hot.

Replacement of heat lost during liquid transfer through pipes up to 3-in. diameter is the function of GE's new pipe heater. Typical applications include restoration of heat level in flowing molten lead, sodium and asphalt.

Each prefabricated unit consists of a steel-sheathed tubular heater mounted on a 3-ft.-long aluminum reflector that is in-

"TALK IS ALL ABOUT THE FIFTEEN MILLION FEET OF UNIONWELD STAINLESS PIPE AND TUBE NOW USED IN PROCESS PLANTS."

"Sure, but what's in it for me?"

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sulated with calcium silicate. Heater rating is 600 w. at 120 or 240 v. Thermostat range is 0 to 650 F.—**General Electric Co., Schenectady, N. Y.** 88D

Pipe Insulation

Made of rigid cellular glass for 35-350 F. range.

Vaporproof, waterproof and incombustible, new Foamglas Stay-Dry pipe covering features ease and speed of installation. It installs before or after hanging of the pipe—hangers around the covered pipe do not compress Stay-Dry. Pipe priming is unnecessary prior to application. Cost runs about the same per linear foot as other commercial insulation.

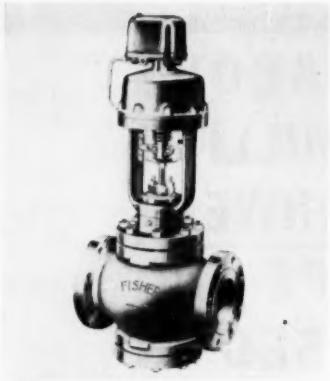
Shipped in 24-in. lengths, Stay-Dry has a factory-applied wrapping of kraft and aluminum foil laminate. Each section opens lengthwise to fit around the pipe; the longitudinal seam of kraft-foil laminate is sealed with lapping cement. Fabricated shapes are offered for covering flanges, valves and fittings. — **Pittsburgh Corning Corp., Pittsburgh, Pa.** 90A

Reducing Valve

Pilot-operated unit for pressure regulation.

Offered in 2½- and 3-in. sizes, a new pressure reducing valve features an integral pilot with filter screen and oversize, clog-resistant passages. Straight-through flow minimizes turbulence for accurate regulation. And, self-lapping seats assure tight shutoff.

Both sizes are suitable for pressures to 250 psi. and temperatures to 400 F. Material of construction for parts other than body, cap and diaphragm is stainless steel; body and cap are cast iron; diaphragm is bronze.—**OPW-Jordan, Cincinnati, Ohio.** 90B



Valve Operator

For more force and higher stroking speeds.

Type 470 pneumatic piston operators function on any supply pressure up to 150 psi., and create stem forces from 1,500 to 12,000 lb. Maximum stroking speed is 1.5 in./sec. An enclosed positioner comes as an integral part of the new unit.

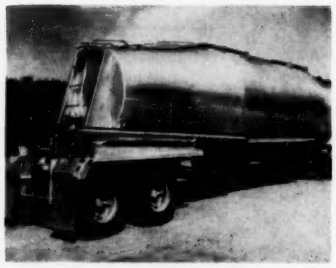
Accessories include a manual side-mounted handjack and a hydraulic snubber. A special cylinder is optional for operations requiring longer strokes. —**Fisher Governor Co., Marshalltown, Iowa.** 90C

For More Information . . .

about any item in this department, circle its code number on the

Reader Service

postcard (p. 205)

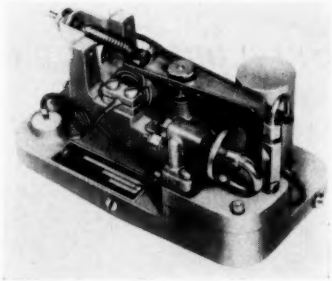


Bulk Trailers

Haul light-weight granular materials.

New aluminum bulk transports designed to haul fertilizers, plastic pellets, salt, alum, etc. are offered in two unloading styles: a center-unloading, gravity-dump model; and also a swivel-mounted auger model that discharges to the rear or either side. Hopper capacities vary up to more than 1,000 cu. ft.

A new twin-screw unloading steel trailer for bulk transport of heavier granular solids is also available. These units come with 640, 740 and 840 cu. ft. of loading volume.—**Butler Mfg. Co., Kansas City, Mo.** 90D



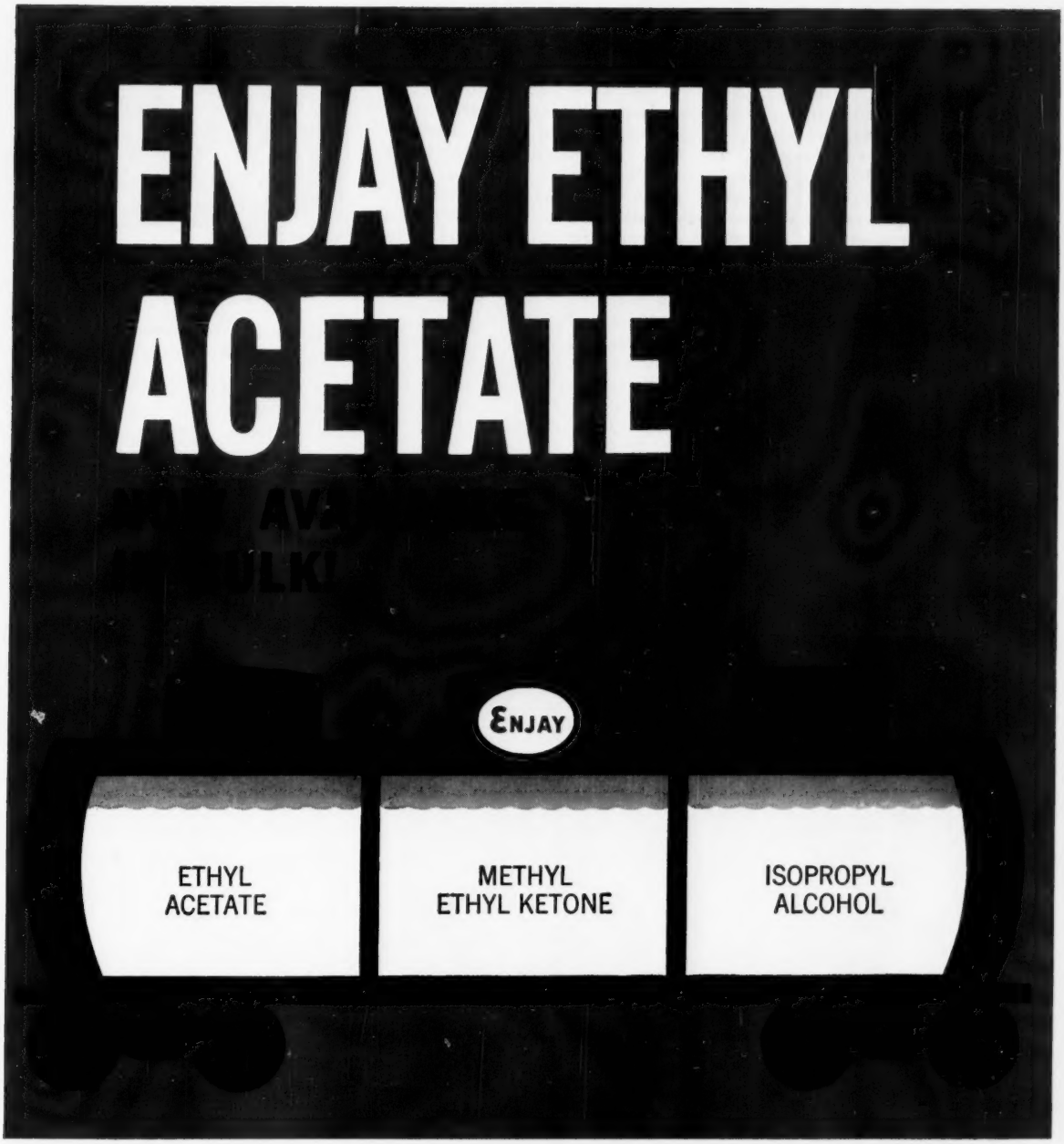
Transmitter

Low-cost unit operates in −30 to 1,200 F. range.

Low in cost, the Sensaire transmitter is a sturdy, compact instrument for temperature measurements in the −30 to 1,200 F. range. According to company officials, the unit offers simple, versatile operation with fewer moving parts, thus assuring longer effective service life.

Sensaire incorporates the smallest bulb sensing element currently available in a filled system. As a result, speed of

ENJAY ETHYL ACETATE



Now Enjay adds Ethyl Acetate to the family of Enjay Petrochemicals. This means you can fill your petrochemical requirements from one *source of supply*. The petrochemicals you order from Enjay arrive in different compartments—eliminating the expense of maintaining large bulk tankage. That way *you* save on receiving and storage costs. Next time you need Ethyl Acetate, Methyl Ethyl Ketone or other high purity petrochemicals for your surface coating or chemical requirements be sure to order from Enjay.

For complete information . . . write or telephone our nearest office for specification sheets and product description bulletin.

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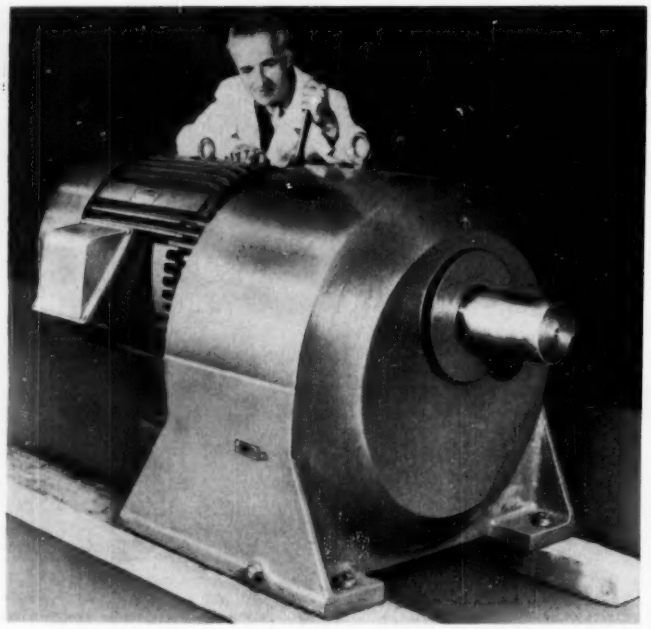
response is as low as 1-2 sec. A thumbscrew adjustment zero-sets over standard temperature range; for broader ranges, a different pre-calibrated thermal system is required. Recommended air pressure is 20 psi.—**Taylor Instrument Co., Rochester, N. Y.** 90E

Bearings

Plastic-fabric material requires no lubrication.

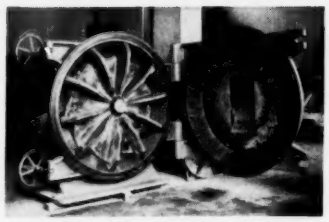
Composed of strong fabric impregnated with phenolic resin, a new low-friction bearing promises to eliminate the need for many metal-to-metal bearings requiring lubrication. According to the manufacturer, Ruslon nonlubricated bearings have outlasted conventional bearings by as much as eight times. Expected mechanical applications range from miniature instruments to hydroelectric stations.

Ruslon bearings consist of a combination fabric of plastic and cotton yarns coated with Bakelite BLS-680 resin. This material is resistant to acids and alkalies, is not subject to salt-water corrosion, and is unaffected by temperatures up to 350 F. A heat-sensitive adhesive bonds the fabric to the metal bearing housing.—**Russell Mfg. Co., Middletown, Conn.** 92A



Largest Gearmotors Can Really Sink Teeth Into Job

Huge new gearmotors — the largest standard drive units ever manufactured—can produce double, triple and quadruple reductions in AGMA ratios up to 440:1. Rated up to 200 hp., sizes J and H GearMotoR drives also feature efficiencies of 94 to 97%. Final stage helical gearing is carburized and hardened, and gear teeth are precision ground. Both machines come with either NEMA flanged or foot-mounted motors; special-feature motors are optional. — Philadelphia Gear Corp., Phila., Pa. 92B



Grinding Mill

For hard-to-handle size-reduction problems.

Pallmann Co. of Germany is now introducing its line of high-speed grinders to the American process industries — hundreds of these units are already in use in Europe.

In operation, the grinder's rotor beats feed material against a pair of stationary conical grinding faces. An air stream removes product from the pulverizing chamber via a gap behind the rotor. Size of the gap, which acts as an internal classifier, is adjustable.

Known as Turbo Mills, Pallmann's machines come in a wide variety of models, each suited for some particularly difficult grinding problem. Typical applications include size reduction of heat-sensitive materials (one unit can efficiently pulverize thermoplastic resins to −40 mesh), grinding of sticky or moist materials, and one-pass pulverization of gritty agglomerates to −325 mesh.—**The Rainville Co., Inc., Garden City, N. Y.** 92C

Leasing Plan

For water, sewage and waste-treating equipment.

A comprehensive plan for leasing water, sewage and waste-treating equipment, with option to purchase, has recently been announced by Infilco, Inc. The plan applies to many types and sizes of equipment.

According to Infilco, the plan is set up to enable industrial customers to take advantage of tax deductions. — **Infilco, Inc., Tucson, Ariz.**

Temperature Recorder and other equipment news on page 182.

THE COMPLETE LINE TO TAKE CARE OF ANY KIND OF PIPE MOTION

Flexonics has the equipment – as well as the experience and the skill – to take care of any kind of pipe motion problem. Here's where you benefit from more research . . . more metallurgical care . . . more service . . . and now standard stock sizes for quick delivery from Flexonics warehouses. They all add up to expansion joints that you can *install and forget* – plus expansion compensators, flexible connectors, and the all-new Flexonics pipe alignment guides–to take care of any kind of pipe motion!

Today–write for your copy of the Flexonics Expansion Joint Design Guide . . . 28 pages of valuable information.

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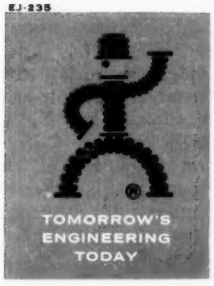

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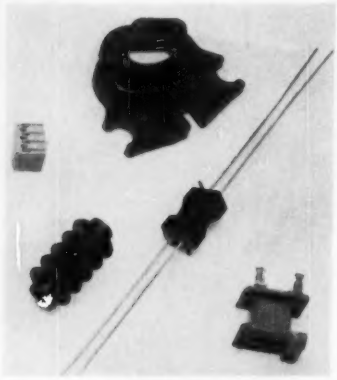
DEVELOPMENTS . . .

CHEMICAL PRODUCTS EDITED BY FRANCES ARNE



Epoxy Molding Powder

Properties suggest uses shown, including coil and resistor bobbins, switch gear.

The first product in a new series, Hysol 8610, is a one-component powder offering long storage stability, low shrinkage on cure, excellent electricals at elevated temperatures and good dimensional stability.

Hysol 8610 with a heat distortion point exceeding 150 C. also offers fast cure at moderate temperatures coupled with good flow characteristics.

Among many potential applications Hysol 8610 is recommended for coil and resistor bobbins, shells for electrical components, relay assemblies, connector plugs, and switch gear. Other important applications include use in dental equipment subject to steam cleaning and for filter plates that must resist severe chemical attack.—**Houghton Laboratories Inc., Olean, N. Y. 94A**

Amides

Light color distinguishes new line of fatty acid derivatives.

Coco, hydrogenated tallow, stearyl, erucyl and oleyl amides are now being made in commercial quantities from the fatty acids which the company already makes at the same plant.

Marketed under the trade name Adogen, the amides are distinguished by their very light color. This is especially important in the use of amides in textile finishes.

Other applications are as foam stabilizers in detergents; in durable water repellants; in plastic films as anti-block agents and lubricating additives; to improve the penetration, flexibility and translucency of wet-waxed paper coatings; to improve adhesion of printing inks; to assist the wax phase of waterproofing and protective coatings emulsions to exhaust into textiles, masonry, metals and paper. — **Archer-Daniels-Midland, Minneapolis, Minn. 94B**

Nylon Resin Properties

	0.3% Moisture Content
Tensile strength, 73 F.	12,300 psi.
Yield strength, 73 F.	12,300 psi.
Elongation, 73 F.	210%
Impact strength, Izod, 73 F.	0.9
Flexural strength, 73 F.	15,500 psi.
Flexural stiffness, 73 F.	265,000 psi.
Heat distortion 66 psi.	367 F.
265 psi.	150 F.

Nylon Resin

High viscosity makes it handle like polyethylene for forming film.

From a new high melt viscosity, high molecular weight nylon resin, .25-mil film can be made on a practical basis. In addition it is said to offer significant advantages in production of flat film, pipe, tubing, rod, profiles and blow moldings.

The new resin has an ASTM relative solution viscosity of more than 800. Other commercially available nylons have shown a top solution viscosity of less than 300.

Uniqueness of the product, a Nylon 6 variety, is attributed to a new polymerization technique. Called SN 607 and developed by Spencer Chemical, it will sell for $1.28/lb., not a premium price.

In extrusion, the function of a high melt viscosity is to increase the strength of the molten polymer during set-up. This increased strength, in turn, imparts more versatile handling characteristics to the extrudate.

Laboratory and field tests have indicated that the resin will enable the extrusion of shapes and profiles which heretofore had to be injection molded or machined. This ability, according to Spencer, could accelerate the consumption of nylon in this market, since extrusion offers definite cost savings over other production methods.

Processors using SN 607 for blown film extrusion can expect, says Spencer, greater drawdown, easier bubble handling, and better wind-up characteristics. In the past, the extent to which they could blow nylon has been too limited to be commercially encouraging.

Within the past few months, a different approach to nylon blowing problems—a new process rather than a new raw material—was announced: Ludlow Paper Inc.'s casting process which can make film out of nylon-6 of conventional viscosity, as well as several other plastics (*Chem. Eng.*, Sept. 8, 1958, p. 55). Ludlow nylon film costs $2.30/lb. whatever the thickness.

And Foster Grant announced developmental production of nylon 6 film (*Chem. Eng.*, Nov. 17, 1958, p. 86).

Minimum thickness of these films are ½ mil and 1 mil respectively, compared to Spencer's ¼ mil. — **Spencer Chemical Co., Kansas City, Mo. 94C**

Quarry mining of rock salt at one of Morton's sources. Nearly 34,000 tons of salt were removed to form this huge room 60′ high and 120′ deep.

Only Morton offers salt service to industry everywhere in America

Morton, the only nation-wide salt company, has salt sources, sales offices and warehouses from coast to coast. This means Morton can offer you complete salt service whether you have just one plant or several plants in different states.

Morton produces, refines and delivers nearly 100 different grades of salt to industry for 14,000 different uses. This means you can get expert, *impartial* advice on which grades will do the best job for you.

Morton has two or more sources for any grade of salt you might use. This means Morton is better equipped to make delivery from alternate plants, even under adverse conditions that might otherwise endanger the continuous operation of your plant.

Morton delivers salt by boat, barge, truck and rail. This means you can get fast delivery on a bag to thousands of tons, anywhere in the country.

Morton sales representatives are backed by the services of their own ultra-modern salt research laboratory—the most complete laboratory of its kind in the world. This means you can get complete technical assistance on any problem relating to salt. This service help alone may be worth thousands of dollars to you every year.

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Styrene-Methyl Methacrylate Properties

Tensile strength, psi.	9,000
Elongation, %	4–5
Tensile modulus, psi.	4.7×10^5
Flexural strength, psi.	17,600
Flexural modulus, psi.	5.1×10^5
Izod impact strength, ft. lb./in. notch	0.4
Hardness, Rockwell M	78
Heat distortion temp., F., 264 psi., annealed	205
Coefficient of linear Ther. expan., in./in./°F.	3.7×10^{-5}
Flammability, in./min.	1.7
Dielectric constant 10^3 c.p.s.	3.13
Dielectric constant 10^6 c.p.s.	2.81
Dissipation factor 10^3 c.p.s.	0.0246
Dissipation factor 10^6 c.p.s.	0.0193
Refractive index, N_D	1.533
Luminous transmittance, %	>91
Water absorption, %, 24 hr.	0.2
Specific gravity	1.14
Mold shrink., in./in.	0.002–0.006

Styrene-Methacrylate

Properties above add up to clear, tough plastic for autos, appliances, signs.

The first member of a totally new family of plastic molding materials is now being marketed. The new material is a copolymer of styrene and methyl methacrylate.

Trademarked Zerlon 150, the product is a thermoplastic said to have excellent clarity, processability, and good weatherability. Zerlon is said to be extremely tough, with good strength, heat resistance and light stability.

Biggest markets for the product, sold in crystal form only, lie in the automotive, appliance and sign fields. Typical uses might be molded and extruded parts such as horn buttons, medallions, knobs, dials, escutheons for major appliances, light fixtures, decorative items and boat windshields. Outdoor uses, such as signs, will probably constitute a major market.

Prices at 49 to 50½¢/lb., depending upon quantity, it is expected to compete with a wide variety of present transparent thermoplastic molding materials.

Zerlon is fabricated like the higher heat resistant formulations of polystyrene, having excellent moldability and extrudability. It can be processed on conventional equipment.—**Dow Chemical Co., Midland Mich.** **96A**

Ion Exchange Resin

First commercially available chelating resin.

A new ion exchange resin that demonstrates high selectivity for heavy metal cations has been announced. The product is Dowex chelating resin A-1.

The resin can be used in removing traces of heavy metals from a wide range of product streams, and in separating various heavy metals. It will remove traces of heavy metals such as iron, copper or zinc from concentrated solutions of alkali and alkaline earth metal salts. In addition, alkaline earth cations may be removed from concentrated solutions of alkali metal cations. The exceptionally high selectivity of the product makes it possible to separate many closely related ionic species such as nickel from cobalt, and copper from nickel.

In most cases where the resin is applicable, separation of metals is difficult by other means. Standard ion exchange resins often lack sufficient selectivity. In other instances, an adequate production rate is not possible with standard resins.

Dowex chelating resin A-1 is easily regenerated by mineral acids, and it has high stability and good sphericity characteristics.—**Dow Chemical Co., Midland, Mich.** **96B**

Fungicide

For paints, it is light colored, stable, widely compatible.

A mildewcide fungicide which has been specially formulated for paint manufacture is tradenamed Puratol-30. A phenyl mercury compound, it is extraordinarily light in color, stable and compatible as an additive with a broad range of oil, alkyd, latex and water-based paints.

Most commercial phenyl mercury oleates, for example have a Gardner color rating of about 5. The Gallowhur product has a color rating of well below 1.

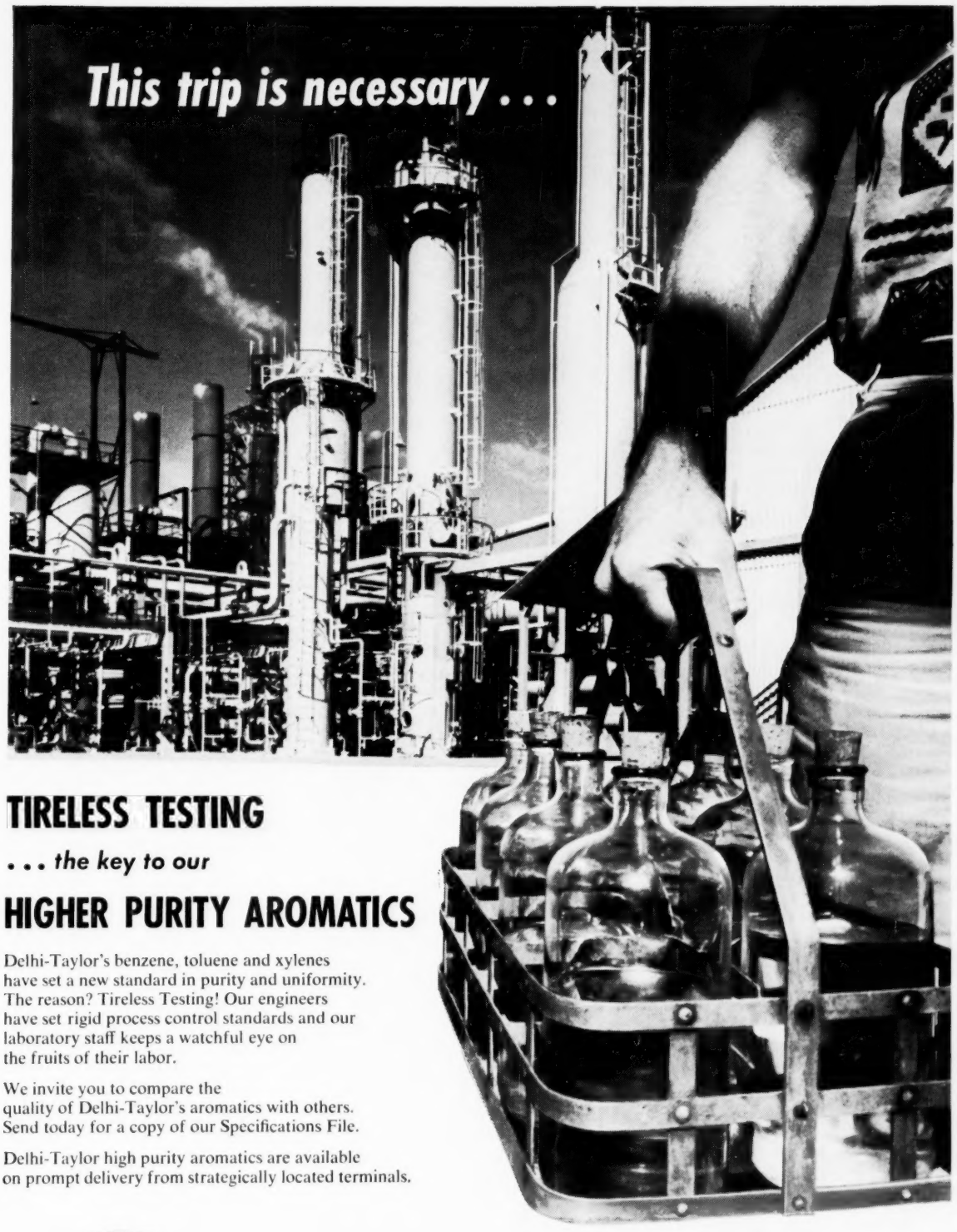
Physical and chemical specifications of Puratol-30 are: Phenyl mercury (calculated as oleate), 30%; minimum equivalent mercury, 10.77%; specific gravity, 0.94; lb./gal., 7.8-7.9; flash point (Tag closed cup), 145 F.; maximum water content, 0.25%; com-

For more details, use Reader Service Card

Page Number is also Reader Service Code Number

Epoxy molding powder offers fast cure, good flow..... **94A**
Fatty amides' light color suggest textile finish use..... **94B**
Higher viscosity nylon forms films more easily..... **94C**
Styrene-methacrylate is tough, clear, weathers well..... **96A**
Resin for chelating is a commercial first..... **96B**
Fungicide for paints is light colored, stable..... **96C**
Sodium borohydride comes in two new forms..... **98A**
Uranium colors return for ceramics..... **98B**
Polyvinypyrrolidone of low molecular weight variety... **98C**
Polyether improves urethanes aging properties..... **98D**
Triazine herbicide for non-selective weed control..... **98E**
Five solvents for chromatography excel 99% purity..... **98F**
New greenish non-flocculating phthalocyanine blue..... **98G**

Newsworthy Chemicals



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CHEMICAL DIVISION

DELHI-TAYLOR OIL CORPORATION

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pletely soluble in petroleum solvents.

On an average, 0.5% of Puratol-30, based on total weight of the paint, is adequate to impart effective mildew and fungus resistance. The Gallowhur formulation will not affect color, viscosity, drying or other characteristics. — **Gallowhur Chemical Corp., Ossining, N. Y. 96C**

Sodium Borohydride

Two new forms: Pellets and stabilized water solution.

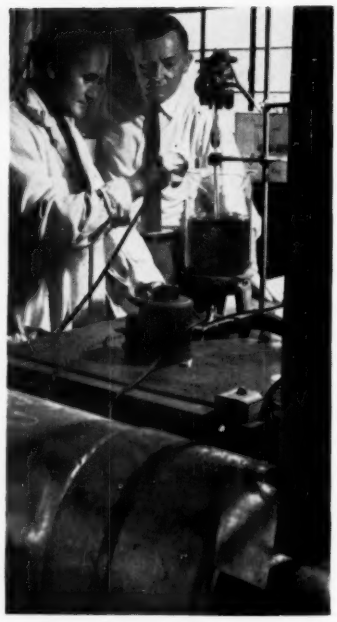
Carrying the lowest price tag of any commercially available borohydride product, a new stabilized water solution is priced on the pounds of 100% pure sodium borohydride contained in a given volume or weight of 12% sodium borohydride. Quantities of 50 gal. or more, therefore, cost about 50% less than pure sodium borohydride.

Vinyl and other plastic and inorganic forms can be prepared with SWS. In inorganic reactions it reacts with certain ions without interference from the caustic. In organic synthesis it effectively reduces aldehydes and ketones. It is an effective agent for the reduction of carbonyl groups to alcohols.

A new pelleted form of sodium borohydride and potassium borohydride simplifies handling and dust hazards while maintaining the same high purity as standard borohydride powder.

Major applications for the pellets include continuous reduction of aldehydes and ketones and fixed-bed purification to remove carbonyl or peroxides from gaseous or liquid olefins, diolefins, alcohols and glycols, amines and aminoalcohols, ethers and polyethers, acrylonitrile and chlorinated hydrocarbons.

Size of the pellets range from 10/32 in. to 24/32 in. in diameter, and bulk density averages 5 lb./gal. Depending on pellet diameter a premium ranging from $1 to $2.50/lb. above quantity list price is charged. — **Metal Hydrides, Inc., Beverly, Mass. 98A**



Uranium Colors

Cylinder, front, contains first shipment in 18 yr. of depleted uranium for making ceramic colors.

Last June after an 18-yr. ban, the AEC approved the use of uranium for non-nuclear industrial products. Believed to be the first ceramic color producer to take advantage of the new policy, Vitro has announced a liné of colors including yellows, oranges and greens.

Vitro first produced uranium-based colors in 1926, and prior to World War II was the recognized leader in production of uranium-based colors for pottery, glass and porcelain products. The uranium adds brilliance and superior handling qualities to the pigments.

The new colors are being made at Vitro's Pittsburgh plant. The uranium salts necessary for their production are being processed by another Vitro division. These salts are processed from depleted uranium from AEC stocks available on an unclassified basis to licensed users. The resultant colors contain a small amount of uranium and are safe to users and handlers. No harmful radiation is involved.—**Vitro Corp. of America, New York, N. Y. 98B**

BRIEFS

Polyvinylpyrrolidone of a low molecular weight variety is commercially available for the first time. Called PVP K-15, it is a white powder, particularly good as a dispersant to detergent systems, pigment formulations, cosmetic applications.—**General Aniline & Film Corp., N. Y., N. Y. 98C**

For rigid urethane foams, a new polyol polyether designated Niax triol LK-380 improves aging characteristics, and reduces water sensitivity. Price is 34¢/lb.—**Union Carbide Chemicals Co., New York, N. Y. 98D**

Triazine herbicide, a 50% wettable powder called Atrazine 50W, has been developed for non-selective or industrial weed control on noncropped land. Product acts through the roots, shows promise for use on agricultural crops such as corn. — **Geigy Chemical Corp., Ardsley, N. Y. 98E**

Five solvents certified to a mol percent purity of 99+% are now available as standards for chromatographic apparatus. They are: acetone, benzene, carbon tetrachloride, methyl alcohol, methylene chloride. — **Fisher Scientific Co., Pittsburgh, Pa. 98F**

Green shade, non-flocculating type phthalocyanine blue, Solfast Blue G 43100 has been developed for inks, paints, plastics or rubber. It may be dispersed to its ultimate desirable characteristics with a minimum of grinding. It gives inks with good body.—**Sherwin-Williams Co., Chicago, Ill. 98G**

For More Information

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U.S.I. CHEMICAL NEWS

Feb. ★ A Series for Chemists and Executives of the Solvents and Chemical Consuming Industries ★ 1959

Polyethylene Properties Of Great Value to Labs Handling Radioisotopes

Polyethylene's properties of radiation-resistance, chemical inertness and physical toughness are proving invaluable to a fast-growing group of chemists and engineers who work with radioactive isotopes in the laboratory.

Contamination—its prevention and elimination—is of course the greatest concern of those who work with radioactive materials. Polyethylene reduces the problem in a number of ways. It is nonionic—will not pick up or transmit stray ions readily. It is nonporous and chemically inert—so can be cleaned easily. Polyethylene containers, equipment and furnishings are generally one-piece moldings—eliminating cracks and joints which might trap radioactive particles.

A highly radiation-resistant material, polyethylene can take doses up to six megaroentgens without degradation. In fact, low doses of radiation have been used to improve the heat resistance of this plastic. Polyethylene has even been employed as a secondary shielding for neutrons which penetrate lead.

Polyethylene makers are looking forward to a fast-growing market for their products in the lab—and perhaps even in the plant—as radioactive materials become increasingly available for industrial use.

New Safety Data Sheet Out on Phosphoric Acid

Properties and safe-handling practices for phosphoric acid have been compiled in a new safety reference booklet now available from MCA at nominal cost. The 14-page booklet covers hazards and their control, employee safety, fire fighting, handling and storage, equipment cleaning and repairing, waste disposal, health measures and first aid.

As a producer of wet process phosphoric acid, U.S.I. can supply further data on individual safety requirements for specific uses.

Zirconium Valve Stems Prove Ideal for Acid Service at Mallory-Sharon

After 14 months in acid service, 40 zirconium-stemmed control valves are still operating without a single stem failure at the Mallory-Sharon zirconium plant, Ashtabula, Ohio.

The valves are used in all concentrations of hydrochloric and sulfuric acids, raffinate, acidified hexone, solutions of ammonium thiocyanate and thiocyanic acid, and other solutions. Mallory-Sharon engineers say they have proved excellent in every way—requiring very little maintenance or operator attention.

Designed by an instrument engineer at U.S.I. (one-third owner of Mallory-Sharon Metals), the valves were custom-fabricated

MORE

Finely-Divided Sodium Lowers Costs, Improves Yields in Broad Range of Chemical Reactions

Many New Products, New Processes Made Possible Through Development of Finely-Divided Sodium Techniques.

Sodium in the form of dispersions is offering important advantages in many chemical processes today. It provides a reliable mechanism for controlling reaction speed. It makes possible the addition of immediately available sodium at a desired rate, thereby giving better control of reaction conditions. Many chemicals can now be produced in larger yields, in shorter time and at lower cost than has been possible with other materials or other methods.

Dispersions for Claisen Condensation

In Claisen condensation reactions, sodium dispersions give high yields and fast reaction rates in the production of such compounds as ethylacetoacetate, ethylbenzoylacetate and ethylsodiumoxalacetate. In the condensation of ethylacetate to ethylacetoacetate, for example, a combination of highly dispersed sodium and increased temperature gives practically quantitative yields of acetoacetic ester, based on sodium. The use of this technique eliminates the time-consuming preparation of sodium ethylate.

Organosodium Compounds

Finely-divided sodium now offers a simple, economical route to many old and new compounds of the organosodium type (containing direct carbon-to-sodium bond). These compounds are obtained by halogen replacement, hydrogen substitution or addition.

MORE

Using halogen replacement,

Commercial reactions using sodium dispersions are run in conventional equipment like this jacketed kettle.

Use of Chemical Milling Grows in Metalworking

Many metalworkers are now using chemicals to etch out complex metal shapes to very close tolerances. Large amounts of metal over wide areas, to a depth of about one inch maximum, can be removed economically by this technique on jobs where conventional machining operations would be difficult and costly, or sometimes impossible.

First the entire metal part is coated with a masking compound and allowed to dry. Using a sharp-bladed knife to cut through the cured mask, and a suitable template to guide the knife, the design is transferred to the part. The mask is then peeled from those areas to be chemically milled, and the part is dipped in or sprayed with a chemical solution to etch away the unmasked areas. Caustic soda is one of the major constituents in the etchant to mill aluminum. Magnesium, titanium and stainless steel are chemically milled in acid mixtures which typically are blends of sulfuric, nitric, hydrochloric and hydrofluoric acids.

Chemical milling has been applied successfully on a mass production basis to aluminum, magnesium, titanium, mag-thorium, Inconels, Monels, carbon steels and steel superalloys. It is used widely in the aircraft and missile fields where great weight savings can be achieved over machine milling. Both castings and forgings have been shaped by chemical means. Electronic circuits, steel shipping containers, pump impellers, radar aerials and decorative paneling are among the products outside the aviation field to which chemical milling has been applied.

Sodium Coolant from Reactors Studied for Use In Radiation Processing

The Atomic Energy Commission has contracted for a feasibility study on using the sodium reactor coolant at the Hallam Nuclear Power Facility as a high-level radiation source for industrial processing. The study will investigate the technical feasibility of using the radioactive sodium coolant for industrial radiation processing and of integrating such a radiation processing plant with the nuclear power facility being built at Hallam, Nebraska. Included will be a preliminary design study for the radiation processing plant.

Feb. ★ **U.S.I. CHEMICAL NEWS** ★ 1959

CONTINUED *Sodium*

the U.S.I. laboratories have developed a new route to Grignard reagents as follows:

(a) $RCl + 2Na \longrightarrow RNa + NaCl$

(b) $RNa + MgCl_2 \longrightarrow RMgCl + NaCl$

Sodium is a less expensive starting material than magnesium, and less hazardous hydrocarbons can be substituted for ether as a solvent. In addition, higher yields are obtained with the sodium process.

Another halogen replacement reaction employs chlorobenzene in a sodium dispersion to yield phenylsodium, which can be reacted with toluene in a hydrogen substitution reaction to give benzylsodium. Phenylsodium, benzylsodium and many other organosodium compounds can be reacted with metallic halides such as $AlCl_3$, BCl_3, etc. to yield corresponding organometallic compounds.

Further details on the syntheses possible with organosodium compounds are given in U.S.I.'s free booklet "Sodium Dispersions".

Other Uses for Sodium Dispersions

A suspension of sodium hydride in mineral oil is easily produced by treating a sodium dispersion with hydrogen gas at 250-325°C and 200-500 psi hydrogen pressure.

Sodium dispersions are used to reduce nitriles to amines, ketones to alcohols, metal halides to finely-divided metals, esters to acyloins. They are employed to prepare sodamide and sodium acetylide. These reactions represent only a portion of the possible applications for sodium in finely-divided form.

Sodium Removes Impurities

Finely-divided forms of sodium are also being used to remove impurities from petroleum fractions and other hydrocarbons that do not possess conjugated double bonds. For example, coke oven producers of benzene, toluene and xylene are finding it difficult to compete with corresponding petroleum-based materials in so far as purity is concerned. Particularly, thiophene content is too high. However, by means of a novel U.S.I. process, coke oven aromatics can now be desulfurized with finely-divided sodium.

CONTINUED *Zirconium*

using zirconium sponge from U.S.I.'s own pilot plant—forerunner of the present Mallory-Sharon installation.

In this instance, of course, initial zirconium cost was not a factor. However, the extremely long service life of the material, and the freedom from maintenance problems, bear out Mallory-Sharon's contention that zirconium is very economical over the long pull in applications where lower-priced metals just do not stand up.

In the recent past, zirconium has been a costly material and its availability for industrial applications has been limited. Now, with a million pounds per year of the metal available to industry from the Mallory-Sharon plant alone, costs are continually being reduced. It is possible to foresee fabrication of zirconium parts at costs only 3 to 5 times higher than for equivalent parts in stainless steel. In most cases, improved performance with zirconium will much more than offset the cost differential.

After 14 months in acid service, zirconium-stemmed control valve still operates at Mallory-Sharon zirconium plant, Ashtabula, Ohio.

TECHNICAL DEVELOPMENTS

Information about manufacturers of these items may be obtained by writing U.S.I.

New bottle carrier of heavy-wall polyethylene, designed for safe intra-plant transport of one-gallon bottles of corrosive chemicals and solvents, is now on market. Carrier said to prevent breakage, also to contain bottle contents. **No. 1440**

Eight longer-lived radioactive isotope standards, supplied until now by the National Bureau of Standards only, are available commercially. They are cesium-137, cobalt-60, iron-59, radium D+E, strontium-90, sulfur-35, tantalum-182 and thallium-204. **No. 1441**

New ultracentrifuge auxiliary permits separation, identification and characterization of materials up to 120° or down to 0°C. Broadens ultracentrifuge use in fields where solutes are not soluble enough at normal temperatures. **No. 1442**

Diphenyldidodecylsilane can now be obtained in limited commercial quantities as a new hydraulic fluid for systems subject to temperature and environmental extremes. Claimed to have good lubricating properties. **No. 1443**

Series of data sheets on tank truck shipment of liquid chemicals is now being sold. 35 sheets now available, each on a different chemical, give data on suggested equipment, loading, handling, safety, clean-up, etc. **No. 1444**

Over 200 organo-metallic compounds are cataloged in new brochure now available. Listed by main constituent such as boron, tin. Physical constants given for research chemicals, specs and uses given for commercial chemicals. **No. 1445**

170 Standards for fire safety are compiled in new, 6-volume, 1958 edition of National Fire Codes, now being sold. Includes 38 new or revised standards. Volumes on fluids, solids, buildings, extinguishers, electrical, transport. **No. 1446**

Non-flammable phosphoric acid type cleaner for most metals has been developed. Said to remove rust, metal oxides, oil and grease rapidly in one simple operation. Leaves light phosphate film on steel and zinc. Can be used hot or cold. **No. 1447**

New boron analyzer, designed to measure boron content of liquid process streams continuously to ±1% by volume, is now on market. Detects B^{10} isotope of boron, works on neutron absorption principle. **No. 1448**

Tracer applications for study of organic reactions are discussed in new book now being sold. Intended to stimulate use of isotopes among organic chemists. Appendices list texts on isotope use, organic reaction mechanisms. **No. 1449**

PRODUCTS OF U.S.I.

HEAVY CHEMICALS

Sodium, Metallic: cast solid in tank cars, steel drums, pails; bricks in barrels, pails.

Sodium Peroxide, Sodium Sulfite, Sodium Sulfate

Ammonia, Anhydrous: commercial & refrigeration. Tank cars or tank wagons.

Ammonium Nitrate, Nitric Acid, Nitrogen Fertilizer Solutions

Phosphatic Fertilizer Solution: wet process phosphoric acid.

Sulfuric Acid: all strengths, 60 Baume to 40% Oleum. Also Electrolytic grade to Federal specifications. Tank cars or tank wagons.

Caustic Soda, Chlorine

OTHER PRODUCTS

PETROTHENE® Polyethylene Resins

Pharmaceutical Products: DL-Methionine, N-Acetyl-DL-Methionine, Urethan USP, Riboflavin USP, Intermediates.

Alcohols: Ethyl (pure and all denatured formulas); Proprietary Denatured Alcohol Solvents SOLOX®, FILMEX®, ANSOL® M, ANSOL PR.

Organic Solvents and Intermediates: Normal Butyl Alcohol, Amyl Alcohol, Fusel Oil, Ethyl Acetate, Normal Butyl Acetate, Diethyl Carbonate, DIATOL®, Diethyl Oxalate, Ethyl Ether, Acetone, Acetoacetanilide, Acetoacet-Ortho-Chloranilide, Acetoacet-Ortho-Toluidide, Ethyl Acetoacetate, Ethyl Benzoylacetate, Ethyl Chloroformate, Ethylene, Ethyl Sodium Oxalacetate, Sodium Ethylate, ISOSEBACIC® Acid, Sebacic Acid, Urethan U.S.P. (Ethyl Carbamate), Riboflavin U.S.P., Pelargonic Acid, 2-Ethyl Heptanoic Acid.

Animal Feed Products: Antibiotic Feed Supplements, BHT Products (Antioxidant), Calcium Pantothenate, Choline Chloride, CURBAY B-G®, Special Liquid CURBAY, VACATONE®, Menadione (Vitamin K_3), DL-Methionine, MOREA® Premix, Niacin USP, Riboflavin Products, Special Mixes, U.S.I. Permadry, Vitamin B_{12} Feed Supplements, Vitamin D_3, Vitamin E Products, Vitamin E and BHT Products.

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Walkway to efficient dust control

Pangborn Cloth Bag Dust Collector on the job. This is just one of Pangborn's complete line of wet and dry dust collectors.

See those bags? They're the *collect* in the Pangborn Cloth Bag Dust Collector. And they're efficient! The cloth filter has proved the most practical method for collecting finely divided dry dusts. But Pangborn goes a step further. Pangborn engineering has not only adapted this design to increase its collecting effectiveness but has simplified its construction. This means you save money. The Pangborn Cloth Bag Collector offers maximum efficiency, yet is economical to buy, install and operate.

Pangborn engineering is important to every dust-producing plant, regardless of the kind of collector needed. It is not enough to put a dust collector within a plant. An efficient dust collecting system must be *scientifically* planned, designed and constructed to handle effectively a specific dust problem. This thinking is incorporated into every Pangborn proposal.

The Pangborn Engineer in your area will be glad to go to work for you. He is a dust expert *and will discuss your individual problem at no obligation. And, for more information, write for Bulletin 922 to:* Pangborn Corp., *2600 Pangborn Blvd., Hagerstown, Md. Manufacturers of Dust Control and Blast Cleaning Equipment.*

Pangborn CONTROLS DUST

"Give your instruments a break . . ."

LET an instrument man make the perfect match between instruments and accessories. Your Honeywell instrument sales engineer knows your process and its controls, and which accessories are best suited to both. He can choose from a broad line of charts, inks, thermocouple wire, wells and protecting tubes.

Additional advantages gained from buying Honeywell accessories are service, economy and single-source purchasing. No shopping around. No need to "mix breeds." And you can be sure that whatever you buy will be right for the job. Your Honeywell instrument sales engineer will see to that. Call him today . . . he's as near as your phone.

MINNEAPOLIS-HONEYWELL, Wayne and Windrim Avenues, Philadelphia 44, Pa.

Here's one product from the complete Honeywell accessories line:

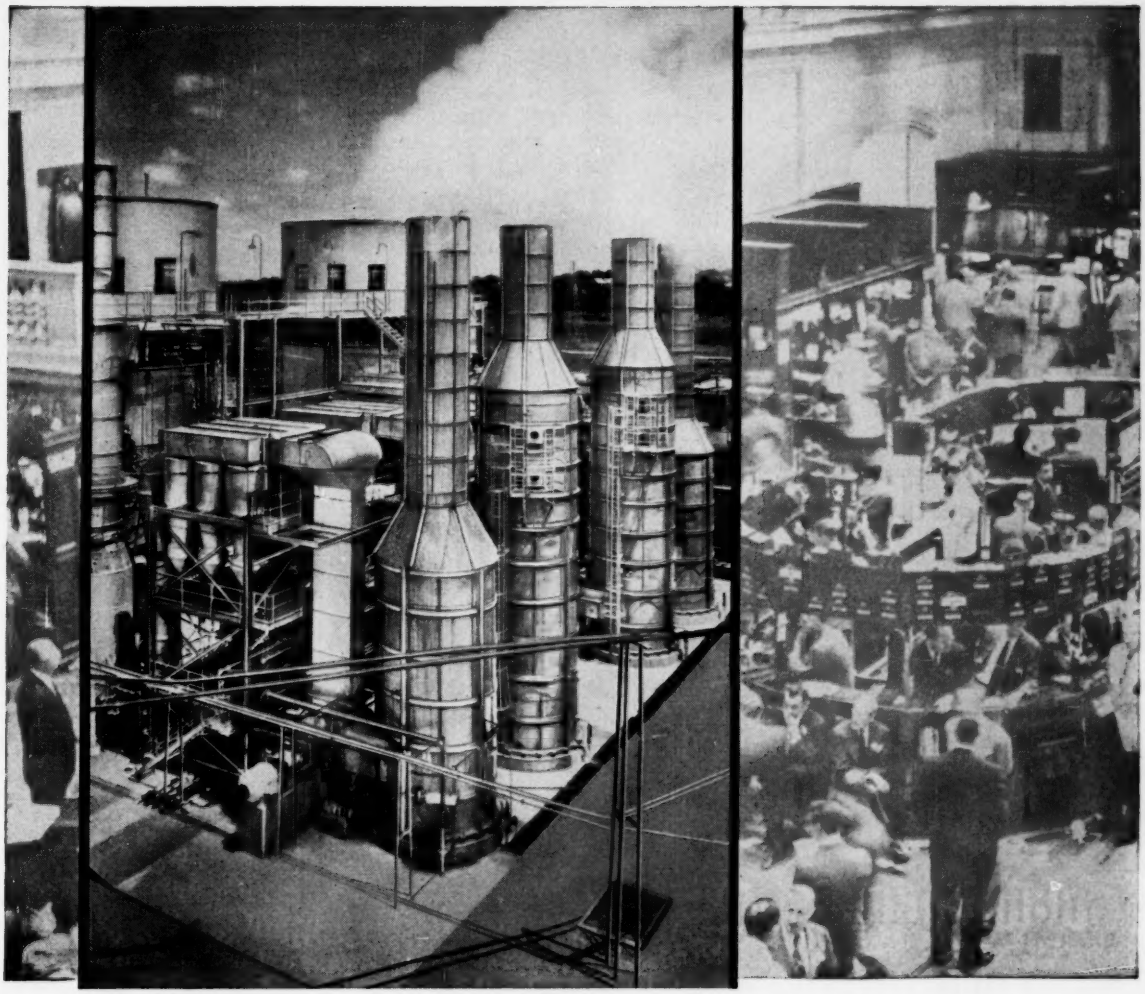
CAST IRON T/C PROTECTING TUBES

This is one of the protecting tubes recommended for use with molten aluminum or die casting applications. It can be used at maximum temperatures of 1300° F. in oxidizing atmospheres, and 1600° F. in reducing atmospheres. Available in standard lengths of 12, 18, 24, 30 and 36 inches.

All Honeywell cast iron protecting tubes are Beta-gage checked for uniform concentricity . . . assuring maximum life.

Honeywell

H HONEYWELL *First in Control*



American Cyanamid gets plant on time, within estimate through Pritchard's GOOD FINANCIAL DESIGN

Modern facilities like this new catalyst plant at Fort Worth, Texas have helped make American Cyanamid a foremost producer of industrial chemicals. The plant, which started with Cyanamid's development of a more efficient way to make a catalytic cracking catalyst, is a superb example of how client-contractor team-work can pay off. Cyanamid furnished the process; Pritchard supplied the plant design and construction service. By emphasizing the financial aspects of plant design while conforming to technical requirements, Pritchard engineers were able to make important savings on material and construction costs. As a result, the plant was completed below cost estimates and will make a better return on investment than originally anticipated.

Next time new facilities are being planned, put Pritchard on your team. In addition to top-flight engineering and years of construction know-how, you'll get the services of a company that can bring a business viewpoint to the planning table. Good financial design is your objective – Pritchard can best help you get it. Pritchard's experience, gained in serving companies such as American Cyanamid, Allied Chemical, Dow, Frontier, Liquid Carbonic, Pure Carbonic, Monsanto and Spencer Chemical, is at your service.

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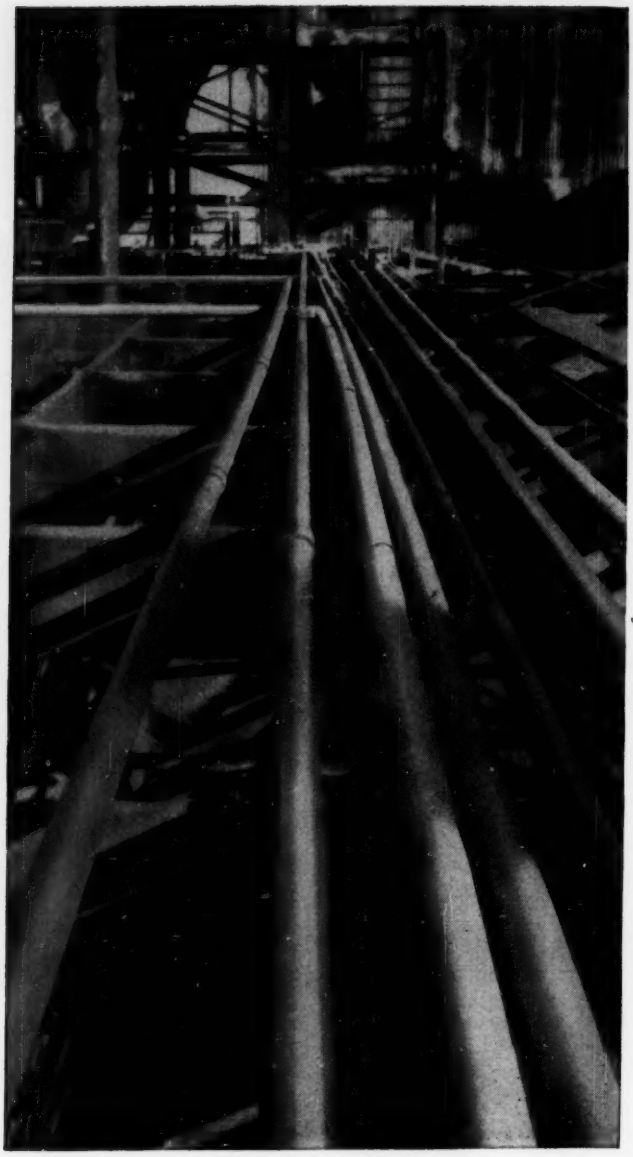
SERVING THE GAS, POWER, PETROLEUM AND CHEMICAL INDUSTRIES

USS National PVC Pipe tames unruly chemicals and gives maintenance-free performance



USS National Polyvinyl Chloride Pipe resists chemical corrosion, does not permit build-up of internal deposits, cleans easily, installs easily, and has a low initial cost. What's more, National PVC Pipe *does not contaminate* sensitive solutions.

USS National Polyvinyl Chloride Pipe has a variety of uses in the chemical industry, because it handles acids, alkalies, salt solutions and alcohols with the same impunity with which it transports water.

Two types of USS National PVC Pipe are available:

Normal Impact—for installations requiring the highest chemical resistance attainable, together with high strength and excellent creep resistance.

High Impact—for installations requiring excellent chemical resistance and a high degree of toughness, even at low temperatures.

USS National PVC Pipe comes in sizes from ½ inch to 14 inches in diameter, and in Schedules A, 40, 80 and 120.

If you'd like more information, write to National Tube Division, United States Steel Corporation, 525 William Penn Place, Pittsburgh 30, Pa. Ask for Bulletin No. 24. *USS and National are registered trademarks*

"The world's largest and most experienced manufacturer of tubular products"

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Columbia-Geneva Steel Division, San Francisco, Pacific Coast Distributors
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Photo courtesy Standard Oil Co. (New Jersey)

LOOKING FOR MORE HEAT

FROM THE FUEL YOU'RE NOW USING?

AN AIR PREHEATER CAN PUT AN EXTRA 1000° INTO YOUR FURNACE

You can get more heat – from the same amounts of your regular fuel – with a Ljungstrom® Air Preheater. An Air Preheater can recover as much as 1000°F from the exhaust of stills or boilers and return it to the combustion air of any kind of fuel-burning equipment. Extra furnace efficiency will in turn permit use of advanced boiler designs, finer controls and a more uniform, more profitable product.

You save fuel with preheated air, too. Even if you recover only 45°F from stack gas, you'll save 1% of your fuel bill. Recover 1000°F, and you can maintain present operating temperatures *on 20% less fuel.*

There's also less maintenance on a Ljungstrom-equipped furnace. Fuel burns more completely in preheated air, so there's less slag, fewer deposits, higher availability of equipment. What you save on maintenance and fuel alone will pay for your Air Preheater in two years or less. "Write-off" can be cut to *as little as nine months* if you use the extra capacity of a preheated furnace to boost product quality.

Free facts on fuel savings

One company's fuel savings with an Air Preheater are factually described in an article by Oliver F. Campbell. Write today for your free copy.

THE AIR PREHEATER CORPORATION

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COOPER ALLOY VALVE BRIEFS

THE VALVE AND FITTINGS ANSWER CORNER

Carl Tylka, Cooper Alloy Technical Service Director, answers your questions on stainless valves and fittings.

Q. *How can one remedy a hydraulic hammer produced in a piping system during closing of a motor-operated gate valve?*

A. Hydraulic hammer indicates an excessive pressure buildup rate caused by too rapid a valve closing cycle. Lengthening the time of closure will eliminate this condition.

Q. *What to do about interruption of closure of motor-operated gate valve caused by the torque switch cutting out when in the near-closed position?*

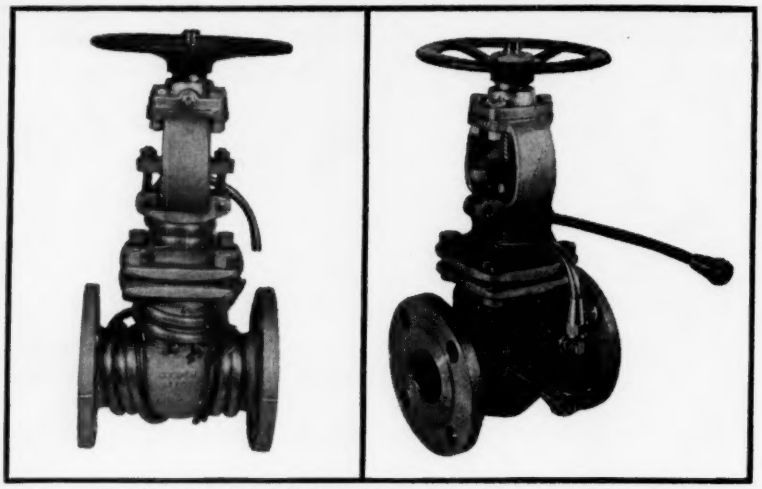
A. Increase the spring load in the operator torque cutout. Obviously, the disc when approaching the closed position develops across it larger pressure drops and resulting friction, which requires operating power in excess of the maximum passable through the torque cutout.

Q. *Does V2B stainless alloy lend itself to use in valve discs?*

A. Yes. V2B's corrosion and erosion resistance, plus its non-galling characteristics, are ideally suited for valve disc applications. Typical Brinell hardness values range from 302, as cast, to 363 when annealed and hardened. V2B contains Mo, Si, Cu, and Be, and is easily machined in the quench-annealed condition (Brinell 269). Corrosion resistance to H_2SO_4, HCl, H_3PO_4, and their salts in the hardened condition exceeds that of all other precipitation-hardenable alloys, and even 316-type stainless. Its resistance to highly concentrated hot HNO_3, however, is less than that of 304 and 316.

Q. *In open-shut operations, which type gate valve is preferable: wedge type, or parallel-faced disc type?*

A. This depends on many variables such as system pressure, temperature, and differential pressure across the disc. With low system pressures and temperatures, the wedge type is preferred for positive shutoff. With high temperature-pressure systems, however, since shutoff tightness is directly affected by pressure drop across the disc, the parallel-faced disc type is preferable, especially in regard to required stem torque and disc binding.



Thermon fills voids between body and tubing, providing continuous heat-flow path between heating element and valve body. It can be easily removed for repair of leakage in tracers

We've Cut Jacketed Valve Cost By 75%

Standard Cooper Alloy stainless steel valve models with low-cost Thermon* jacket are designed for use in hot or cold service

Thermon, a non-metallic plastic compound with highly efficient heat-transfer properties when factory-applied to standard Cooper Alloy stainless steel valves with conventional steam traced or thermal electric systems, permits all the performance advantages and none of the problems generally associated with jacketed units. You can even use standard piping without juggling sizes, and product contamination, usually a big problem with most jacketed units, is not possible, because we have eliminated the need for complicated castings which are subject to hidden defects.

What's more, the costs are one-quarter of what you would expect to pay for jacketed valves. Thoroughly tested under all operating conditions, Cooper Alloy Thermonized valves have the high performance characteristics equal to the most efficient jacketed units, in operating temperature ranges from below zero up to 750°F.

Cooper Alloy Thermonized valves make maintenance problems easy. Should tracer leaks develop, they can be quickly found and repaired. With a minimum of down time required, your processing operation can be continued without a great loss of productive hours and manpower.

With Cooper Alloy Thermonized valves you get all the high quality features you expect in a Cooper Alloy product. You get high-performance, lower-cost jacketed valves, and you can get practically off-the-shelf delivery to meet your production needs. For further details, request engineering data folder from Cooper Alloy Corp., Hillside, N. J.

*Thermon is a product of the Thermon Mfg. Co., Houston, Texas.

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GLASS BOTTLE HOLDER-CARRIER

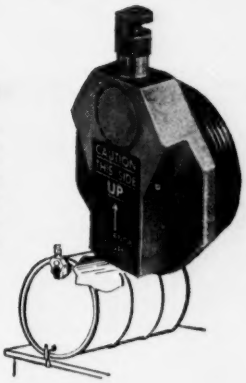
Polyester urethane-lined can prevents breakage of glass bottles containing hazardous liquids. Safeguards transporting bottles thru plant-lab.

Coupon No. 23

SPACE-SAVING SAFETY CAN

Oval shape requires minimum storage space, permits natural, close-to-body carrying. Flexible spout safely speeds dispensing—no spillage. 5-gal. capacity.

Coupon No. 15



SAFETY DRUM VENT FOR END-BUNGS

Fire-explosion safe flame arrester vent designed to fit end-bung openings of drums stored horizontally. Stops leaks. Provides pressure-vacuum relief.

Coupon No. 16

WASTE LIQUIDS DISPOSAL BOTTLE

Glass bottle in terne plate shell provides for safe disposal of corrosive liquids-acids. Polyester urethane lining prevents breakage of bottle in transit.

Coupon No. 24

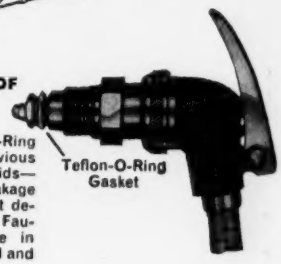
NEW DEVELOPMENTS IN FLAMMABLES SAFETY FOR THE CHEMICAL PROCESS INDUSTRIES

New developments in the safe, productive use of hazardous liquids occur frequently. Often, these developments result from the needs of a single Protectoseal user — needs for which adequate safeguards did not previously exist. When these developments can be applied to operations in other plants, they are made available. The examples here are the most recent.

LEAK-PROOF SAFETY FAUCET

New Teflon O-Ring gasket impervious to most liquids—prevents leakage due to gasket deterioration. Faucets available in stainless steel and brass.

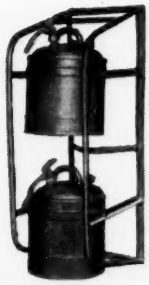
Coupon No. 17



FLAMMABLES STORAGE CABINET

Approved now by N.F.P.A.; Board of Standards & Appeals, City of New York; Penna. State Police Bureau of Fire Protection—for storage of up to 45 gals.

Coupon No. 19



TILT-TYPE SAFETY CANS

Now available with space-saving wall bracket. Cans tilt easily to correct position for dispensing; swing back to upright position after use.

Coupon No. 22

VISCOUS LIQUIDS SAFETY CAN

For storing, dispensing liquids such as rubber cement. "Knife-like" closure blade over spout stops flow of liquid with clean "cutting" action—no sloppage.

Coupon No. 20

Use coupon for complete information

SAFETY DRUM PUMP

Designed for flammable liquids—now made equally efficient for light oils. No safety supervision problems—use a single pump for flammables as well as non-flammables.

Coupon No. 21

FLAMMABLES ENGINEERING DATA FOR THE CHEMICAL PROCESS INDUSTRIES

Send Further Information On Items Checked Below:

15 16 17 19 20 21 22 23 24

☐ Send Entire File Of New Developments In Safety

☐ Send Complete Catalog Of Protectoseal Equipment

THE PROTECTOSEAL COMPANY
1948 South Western Avenue
Chicago 8, Illinois

Name _____ Title _____

Company Name _____

Address _____

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Allis-Chalmers Dielectric Heaters

Efficient, modern operations call for the kind of operating convenience offered by Allis-Chalmers Dielectric Heaters. The controls are grouped at eye-level for quick appraisal of operating conditions. The entire unit is designed for easy accessibility. Wiring arrangements make inspection and maintenance simple and straightforward.

Every detail of Allis-Chalmers Dielectric Heaters is designed to assure full capacity operations with minimum maintenance and supervision. Loadmaster control permits *continuous* operation under *maximum* loads. Protective interlocks assure top safety. Oscillators and rectifiers are built to last for 5000 hours or more. Heavy duty plate transformers assure large reserve capacity.

The same extensive research, design and engineering facilities that produce these dependable dielectric heaters are available to you for expert application and installation guidance. And, Allis-Chalmers offers periodic checkup and fast emergency maintenance service. *Call your nearby A-C man for details, or write Allis-Chalmers, Industrial Equipment Division, Milwaukee 1, Wisconsin. Ask for Bulletin 15B6431C.*

Eye-level controls "tell all" at a glance

Typical applications now using Allis-Chalmers Dielectric Heaters

- Twist-setting rayon cord
- Heating plastic preforms
- Setting glue joints
- Jelling rubber
- Heating inert chemical powders
- Preheating molding powders
- Rayon drying

ALLIS-CHALMERS A-C ALLIS-CHALMERS A-5867

Teflon* SPIRAL WOUND GUARDIAN† GASKETS for high temperatures and pressures

against steam, oils, gases, liquids, including most chemicals. Constructed of spiral wound strips of "V"-shaped preformed 316 stainless steel alternated with layers of TEFLON. Spring action of V-shaped metal plies provides automatic reaction to compression, internal pressure variations, temperature changes. Provides excellent recovery to accommodate varying service conditions. Available to all ASA standards for pressures to 2500 psi and for temperatures to 450° F with TEFLON (with asbestos filler for temperatures to 1050° F).

GUARDIAN Gaskets are another important part of the Garlock 2,000 . . . two thousand different styles of packings, gaskets, and seals for every need. The only complete line. That's why your Garlock representative can give you unbiased recommendations. Call your Garlock representative, or write for Folder AD-104.

THE GARLOCK PACKING COMPANY, Palmyra, N. Y.

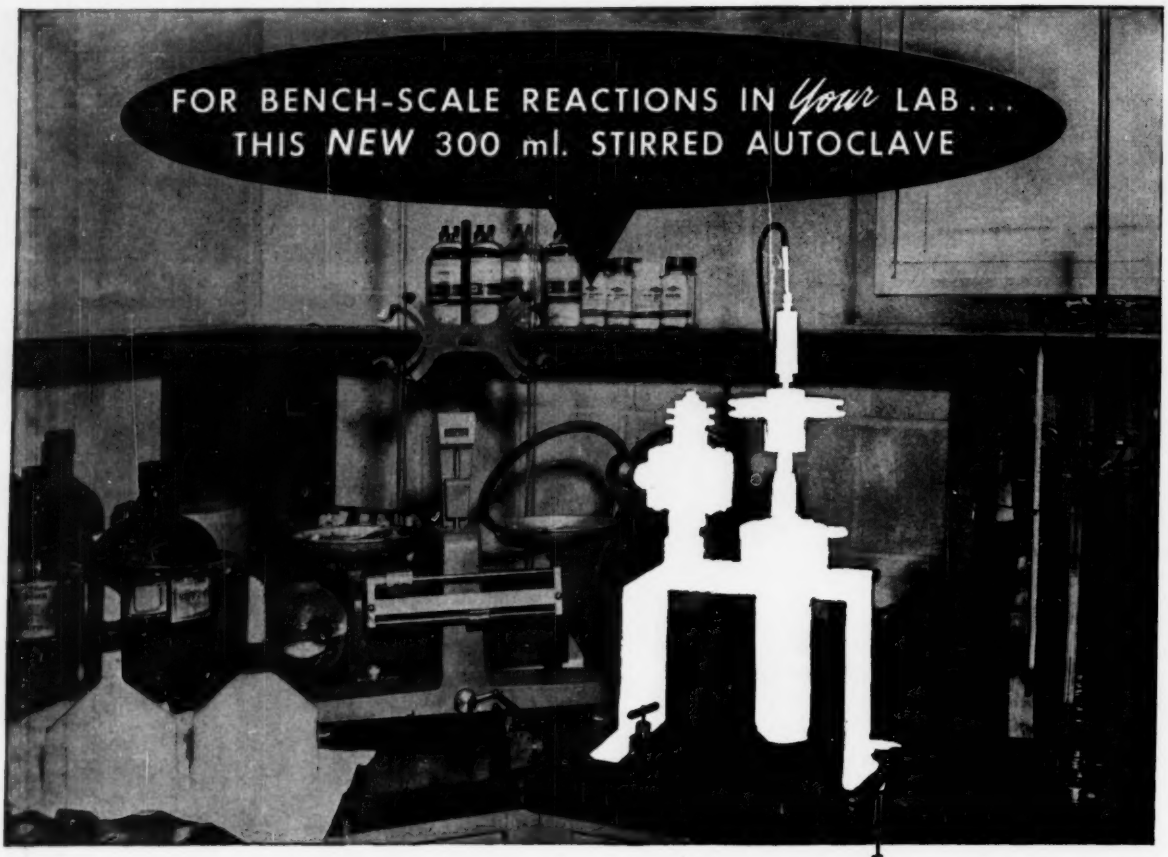
For Prompt Service, contact one of our 30 sales offices and warehouses throughout the U.S. and Canada.

GUARDIAN Gaskets are made in round, oval, square, flat side, diamond and pear shapes in practically any size. Thicknesses ⅛", .175", and ¼" depending on application. Centering devices include a steel ring type to assure accurate positioning and to avoid excessive compression. Also, loop type centering guides are available which fit over opposite bolts.

**Dupont Trademark* *†Garlock Trademark*

GARLOCK

Packings, Gaskets, Oil Seals, Mechanical Seals, Molded and Extruded Rubber, Plastic Products



COMPACT • INEXPENSIVE
EASY-TO-HANDLE

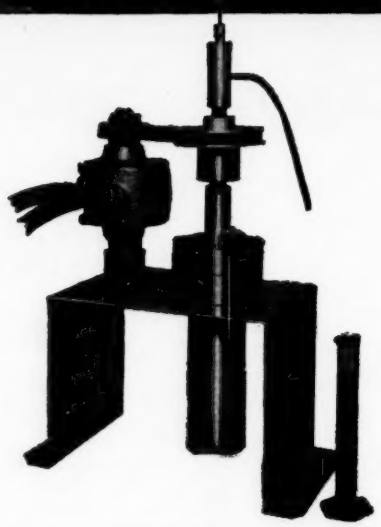
Your Choice Of Air Or Electric Drive

Here is the answer to your need for a bench-scale stirred autoclave you can use in a wide range of pressure reactions. This new AE vessel has a capacity of 300 ml. and is designed for pressures up to 5000 p.s.i. at 650°F. It is a self-contained unit ready for connection to existing utilities in your own laboratory. Equipment includes agitator, cooling coils, electric heating, sampling tube, charging opening, gas openings and your choice of either air or electric drive.

You'll especially like the compact size of this AE ***BENCH-SCALE*** unit. For example, the unit shown here occupies a space of only 7″ x 13″ x 20″ high. Simplicity of design and light weight are other features that assure easy handling and operation.

The body of the vessel and all wetted parts are made of 316 stainless steel. A complete line of valves and fittings for use with the unit are also available.

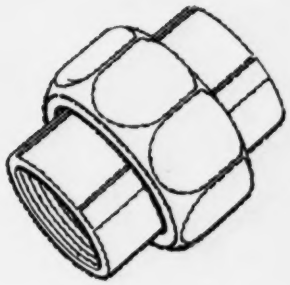
Complete specifications are described in Bulletin 1257-1. Send for your copy today.



AE ***BENCH-SCALE*** Stirred Autoclaves are compact. Model ABA-300 shown here is 7″ x 13″ x 20″ high.

AUTOCLAVE ENGINEERS, INC.
2932 WEST 22nd STREET, ERIE, PENNSYLVANIA

What do Rockwood Unions have to do with Antibiotics?



At Chas. Pfizer & Co., Inc. Rockwood Cold-Forged Unions have to —

- measure up to exacting sterilization pipe line service
- permit quick and easy inspection
- be easy to handle with no galling in make-up
- and be completely interchangeable

Rockwood Unions have all of these advantages because —

Rockwoodizing assures corrosion protection. A special coating process, applied after threading, protects the entire union.

Color-Coding — permits quick and easy inspection.

Hardness Differential assures tight seal. The male seat is specially treated to make it 150 Brinell harder than the female seat — no galling in make-up.

Four Different Seats for every general piping requirement — each completely interchangeable — are available, tested and listed by Underwriters' Laboratories, Inc.

Send for full information —

ROCKWOOD SPRINKLER COMPANY

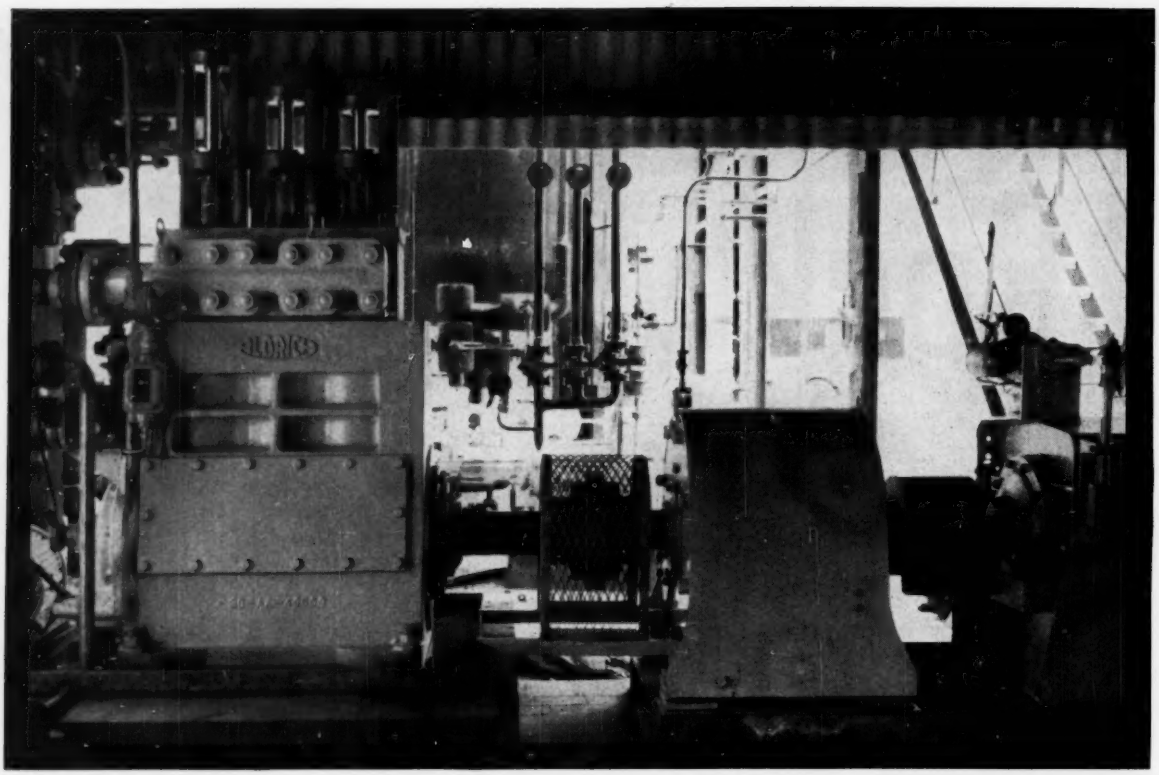
Distributors in all principal industrial areas

ROCKWOOD

ROCKWOOD SPRINKLER COMPANY
2868 Harlow Street
Worcester 5, Massachusetts

Please send me prices and further data on the Rockwood Unions.

Name .....
Title .....
Company .....
Street .....
City .....
Zone ..... *State* .....



THE PRESSURES ARE HIGH...THE LIQUIDS CORROSIVE...THE PUMPS ARE ALDRICH...

At the Houston plant of Rohm & Haas Co., this Aldrich pump alternately introduces caustic and brine into one phase of the acrylate process for producing acrylic monomers.

The problem: Handle highly corrosive liquids at 3000 psi in a continuous process and *not* have severe maintenance problems.

What Rohm & Haas did about it. Company engineers specified Aldrich 1⅝" x 5" stroke Triplex Pumps for three reasons.

1. Compact, heavy-duty construction makes Aldrich pumps ideal for high pressure service.

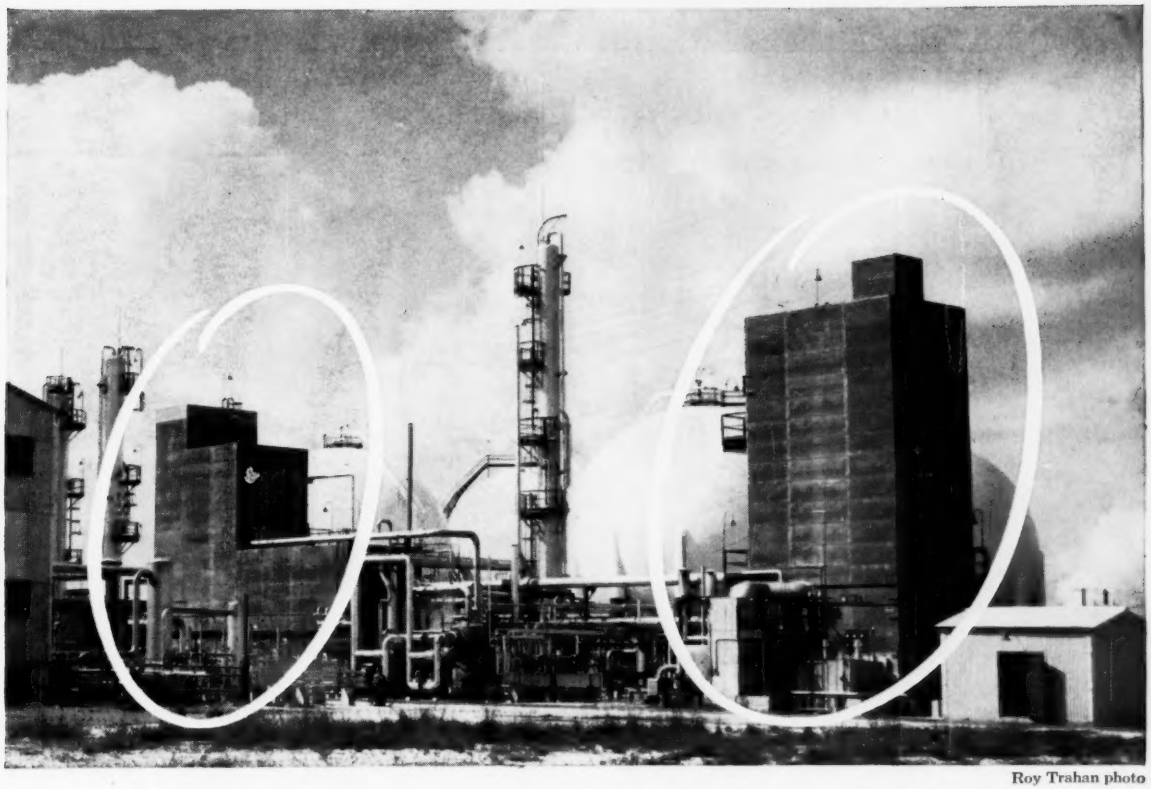
2. Aldrich pumps are designed for easy maintenance. Fluid-end sectionalization permits quick removal of valves for inspection or replacement. No special tools are required.

3. Aldrich engineers can draw upon a vast store of experience when it comes to selecting the right materials for any pumping job. In this case, the entire fluid end . . . working barrel, suction and discharge manifolds . . . are forged Monel. Valve seats are Haynes Stellite. Valves and plungers are K Monel.

Results: According to the Plant Manager of the Houston plant, "maintenance requirements have decreased and pumping production improved. These Aldrich pumps lend themselves to easy maintenance."

How Aldrich can help you. Solving pumping problems like this requires specialized engineering skills and experience. We have those skills, and our experience comes from years of working with the chemical industry. We welcome the opportunity to discuss your specific problems . . . no matter what the liquid or how high the pressures. Aldrich Pump Company, 3 Gordon Street, Allentown, Pa.

the toughest pumping problems go to ALDRICH



Roy Trahan photo

Part of the Petroleum Chemicals Inc. installation at Lake Charles, La., showing the two Air Liquide units mentioned below.

Low-temperature separation at its best!

The large and complex project of Petroleum Chemicals Inc. and Calcasieu Chemical Inc., at Lake Charles, La., is typical of the wide scope and adaptability of low-temperature gas separation.

At the P.C. ammonia producing plant, a raw hydrogen feed stream containing platformer, butadiene, hydroformer and ethylene cracking off gases, is treated by an Air Liquide low-temperature nitrogen scrubbing unit. It is the largest of its kind to handle such a variety of feed streams.

The resulting ammonia synthesis gas, in correct hydrogen-nitrogen ratio and containing less than 20 ppm of total impurities (CO + Oxygen), is rated at the ammonia equivalent of 310 tons per day.

Pure nitrogen for the ammonia and for the liquid nitrogen scrubbing is produced in an Air Liquide air separation plant rated at 100 tons of oxygen per day. Both units will maintain the same product purities even at 60% capacity.

The Calcasieu Chemical plant, with an Air Liquide 180-ton-per-day oxygen unit, uses the gas directly to manufacture ethylene oxide. This unit, differing from the conventional design, is a low-pressure regenerator type producing at the required pressure of 225 psig using liquid oxygen pumps. This special Air Liquide cycle eliminates the problems of oxygen compressors and results in a safe plant with lower power consumption and good process control.

Behind these achievements is more than half a century of design and engineering experience which can help you solve your own low-temperature problems.

Thousands of Air Liquide plants of every type are in use throughout world industry. Here are some of them.

- Air separation—oxygen, nitrogen, and rare gases.
- Coke-oven gas separation.
- Refinery gas separation.
- Methane purification.
- Natural gas liquefaction.
- Pure CO production.
- Heavy water — for atomic reactors.
- Hydrogen liquefaction.
- Helium recovery.

For complete information, write or call

AMERICAN

AIR LIQUIDE

ENGINEERING & CONSTRUCTION DIVISION

OLDEST IN EXPERIENCE—NEWEST IN DESIGN

405 LEXINGTON AVE., NEW YORK 17, N.Y.

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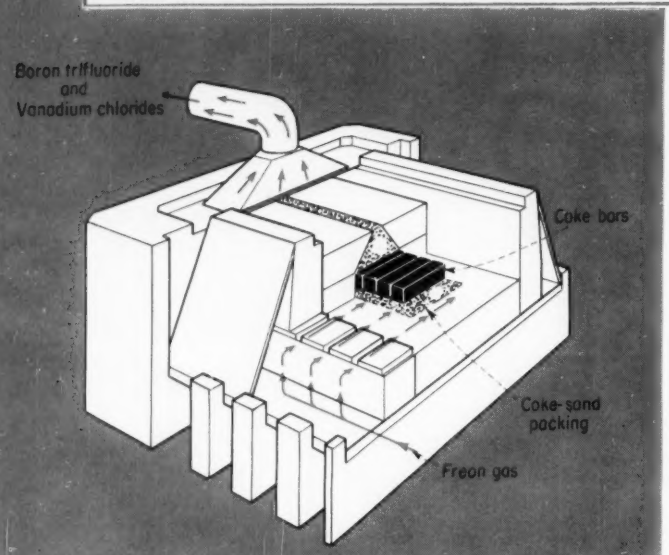
DEVELOPMENTS . . .

PROCESS FLOWSHEET

C. S. CRONAN



Within this graphitization furnace, Freon gas decomposes to form halogens that unlock boron and vanadium from graphite. . . .

Purifying Route to Nuclear-Grade Graphite

With demands for nuclear-grade graphite keyed to rapidly advancing reactor technology, production facilities must be geared to meet a wide variety of exacting specifications. For those specific applications where reactor design demands extremely high-purity graphite, National Carbon Company, Division of Union Carbide Corporation, employs complex processing techniques.

Since the birth of the budding nuclear industry, hundreds of millions of pounds of graphite purified by various means have been used to moderate and shield nuclear reactors all over the world. Graphite's low neutron capture cross-section, absence of a practical melting point, high thermal conductivity, increased strength at high temperatures, relatively low cost, general availability, and excellent machinability make it important in reactor operation.

► **Must Be Pure**—Neutron economy is the key factor in many nuclear applications, and the graphite must be free of impurities such as boron and vanadium that are notable neutron grabbers. Though usually present in only a few parts per million, boron's high neutron affinity makes it by far the worst offender among commonly-encountered impurities.

Too, density is maintained within narrow limits to control fuel spacing and loading. Though unrelated to density, impermeability has become more-and-more important with the development of gas-cooled reactors.

National Carbon reduced permeability to gas flow, at a 1-atm. pressure differential through a 1-cm. cube of graphite, from 300 ml. to approximately 0.0004 ml. in new grades of nuclear graphite.

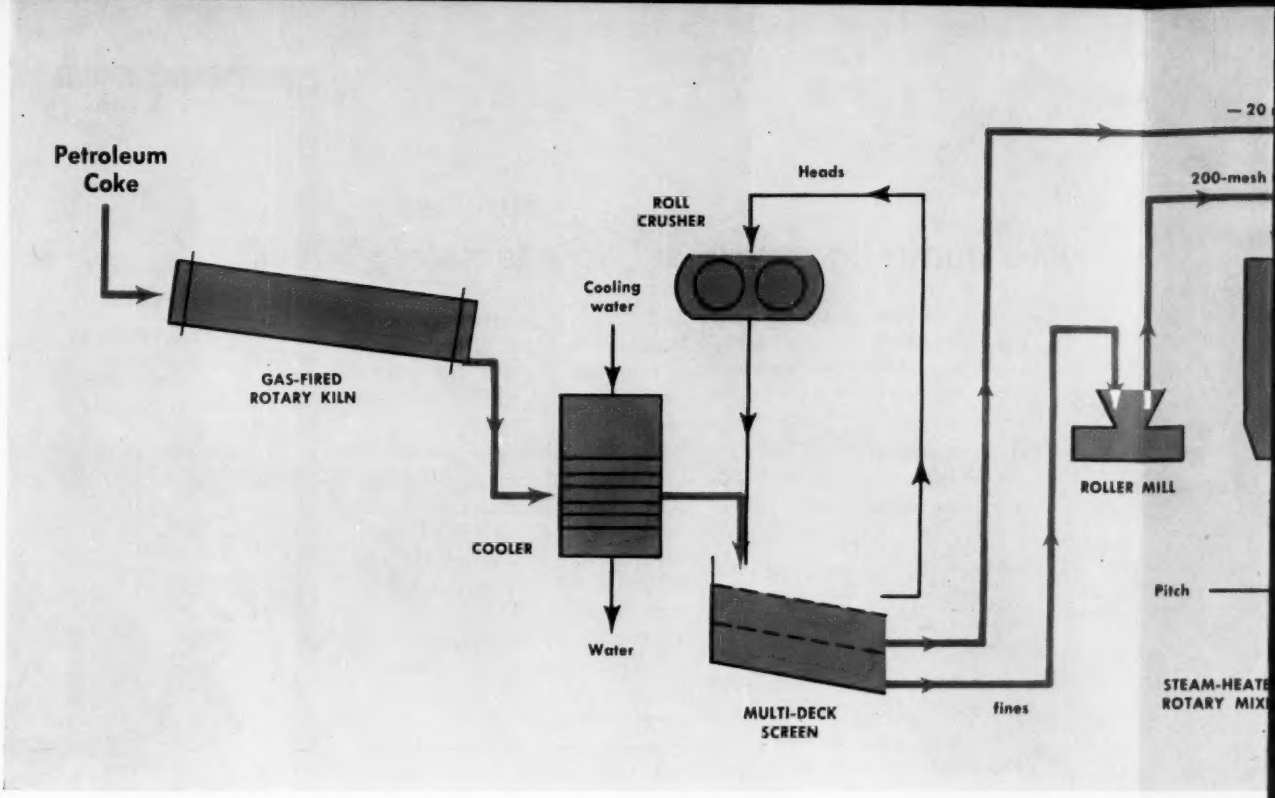
► **How It's Purified**—To meet these stringent product-purity requirements, National Carbon imposes strict quality controls on its graphite-producing process from beginning to end.

Pitch-impregnation step interposed between baking and graphitizing maximizes density (as is also done for some non-nuclear grades). Graphitization for longer periods at higher-than-normal temperatures (5,000-5,400 F.) assures maximum volatilization of low-boiling impurities such as silicon, calcium, aluminum, and magnesium.

To free graphite of high-boiling impurities such as boron and vanadium, Freon (dichlorodifluoromethane) gas is forced through the graphitizing-furnace bed. At the high graphitizing temperature, Freon dissociates to form free chlorine and fluorine.

Resulting gas mixture attacks boron and vanadium impurities, converting them to volatile boron-trifluoride and vanadium-chlo-

Unfold Flowsheet



rides. Impurity-bearing gases discharge from the furnace, leaving behind high-purity graphite with a boron content as low as one part in ten million.

▶**Process Fow**—A 125-ft.-long, gas-fired rotary kiln calcines petroleum coke at a maximum temperature of 2,750 F. to drive off and burn its 7-16% volatile hydrocarbon content, thus minimizes bulk changes in the steps to follow.

Coke, conveyed through tubes under a water spray, is cooled and thus readied for screening. Cooled coke feeds a multideck screen which sifts coarse, intermediate and fine fractions.

Coarse heads recycle through a roller crusher and multideck screen; intermediate fraction (U. S. Standard, −20 mesh) is conveyed to bins for storage; roller mill crushes fines to a U. S. Standard 200 mesh flour which is also conveyed to storage bins.

▶**Scrambling Coke and Pitch**—Steam-heated, rotary mixer blends screened coke flour and particles, supplied from storage bins, with pitch which melts at the 330 F., mixing temperature. Air tumbler cools pitch-coke mixture by exposure to ambient air.

Hydraulic extrusion press compacts the coke-pitch mixture into "green bars." Standard cross sections range from 4½ in. to a little more than 16 in. square. Bars are either air or water cooled to harden the pitch binder and thus prevent distortion during further handling and storage.

Overhead crane handles bars in charging a gas-fired baking furnace. Coke-sand mixture, tightly packed around the green bars, prevents distortion of shape as they are heated above melting point of pitch binder.

▶**Six Weeks of Fire**—In a continuous baking cycle, volatile hydrocarbons are displaced from pitch binder at about 570 F. As temperature increases to about 840 F. considerable shrinkage occurs as binder hardens. Temperature increases to approximately 1830-F., baking temperature. Entire cycle, including cooling period, takes up to 6 weeks.

Impregnation with pitch binder maximizes final product's density, is carried out in a vertical autoclave. Baked bars are first loaded into a vessel for preheating to 480 F. Vessel is lowered into the autoclave, which is then sealed shut. Evacuation to less than 1/10 atm. followed by rapid charging of vessel with hot pitch under 100-psi. pressure assures thorough impregnation of bars.

▶**Ready for Graphitization**—Pitch-impregnated bars are positioned between head electrodes of an Acheson resistance furnace. Granular coke-sand mixture, packed between stacks of bars, holds them in position and is replaced with fresh pack on each loading to prevent contamination.

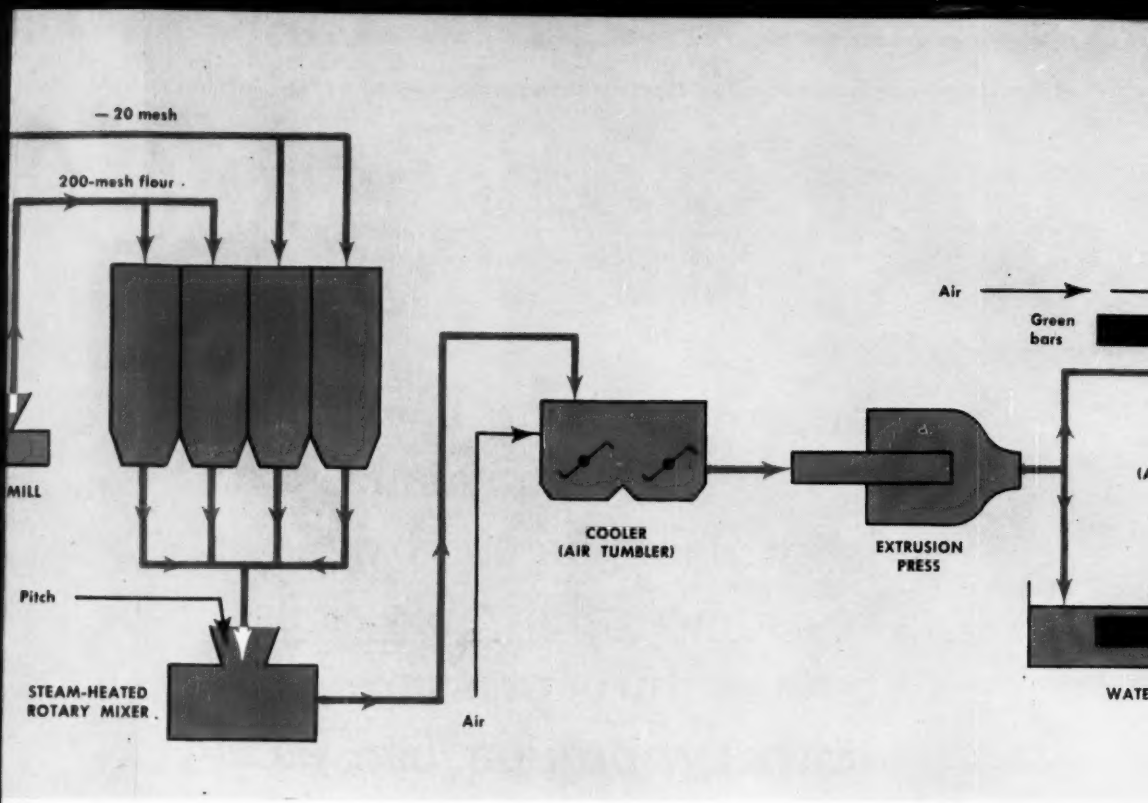
Electric power, supplied to the furnace at the rate of from 600 to 4,000 kw., heats the bars to 5,000-5,400 F. During the heating cycle Freon gas is forced into the furnace bed pores.

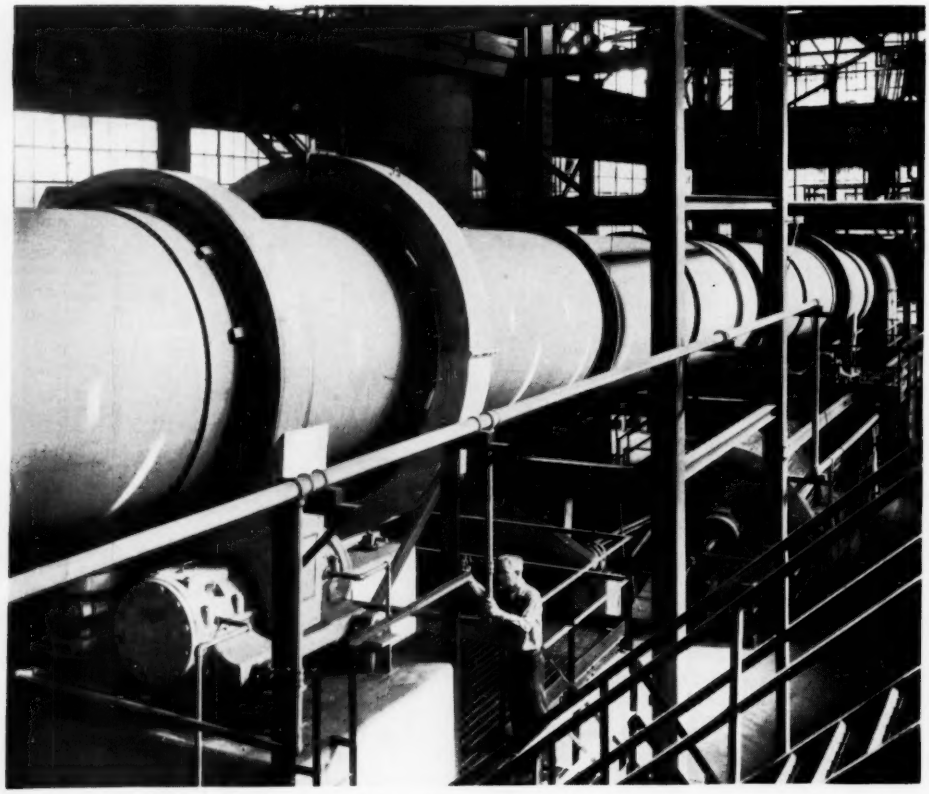
▶**Gases Attack Impurities**—Fluorine and chlorine formed by Freon dissociation react with impurities. Resulting volatile gas-reaction products exhaust upward through a vented hood over the furnace, then through scrubber that removes objectionable gases such as BF_3.

Resulting high-purity graphite bars, removed from cooled graphitizing furnace, are stored to await machining.

White-gloved operators wrap nuclear-grade graphite bars in boron-free paper and stack them in unit loads on special pallets wrapped with polyethylene to weatherproof them during shipment.

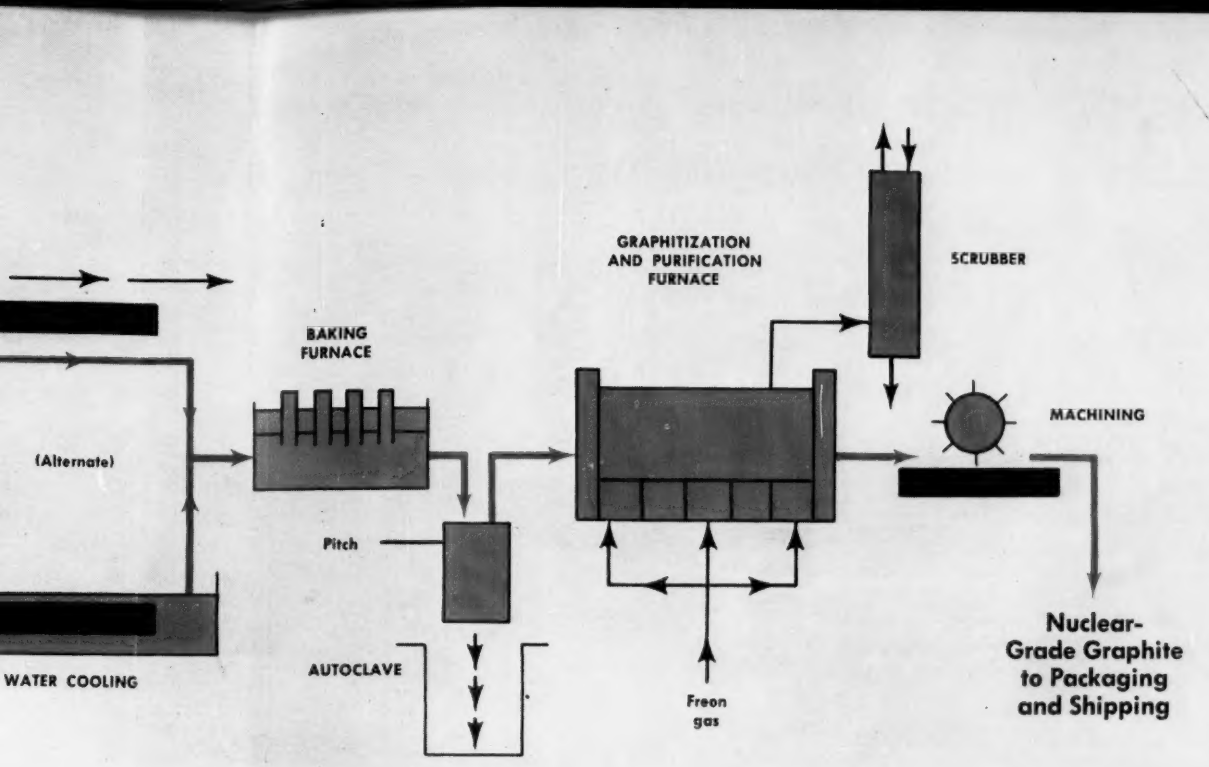
CALCIN
volatile h



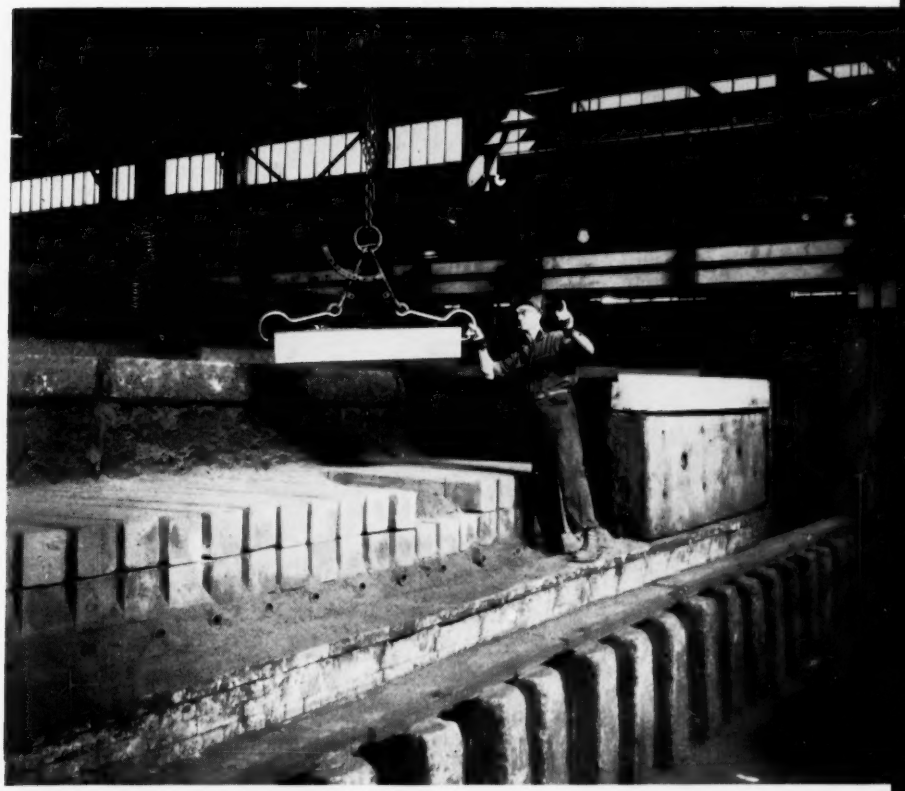


CALCINATION: Gas-fired rotary kiln, 125 ft. long, calcines coke to drive off and burn volatile hydrocarbon content, thus stabilizes coke's bulk density.

PITCH IMPREG
bars are preheate



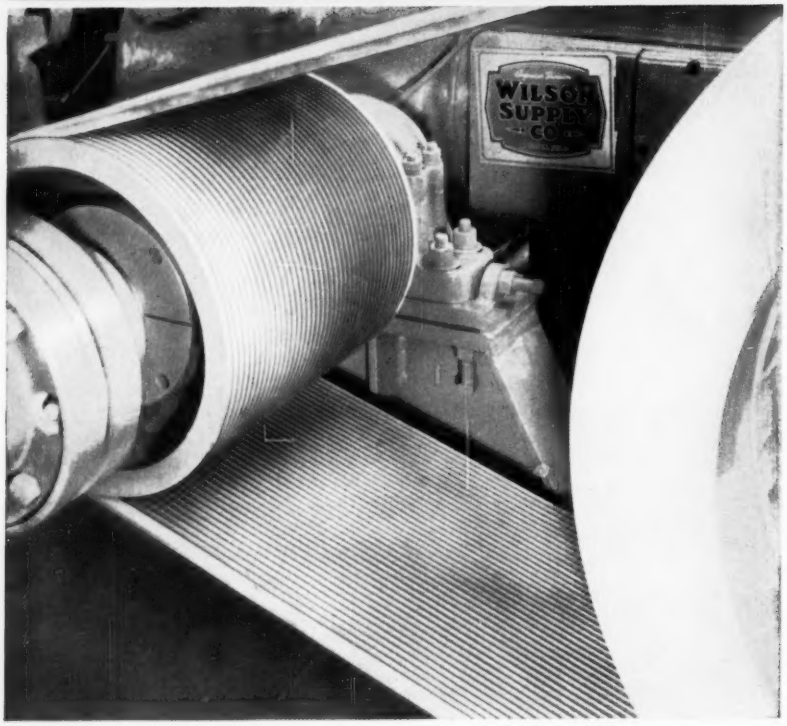
REGNATION: Vessel, charged with baked heated, is lowered into vertical autoclave.

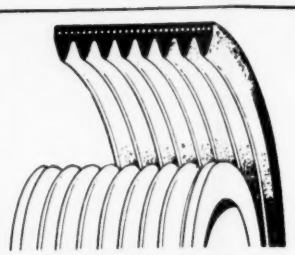


GRAPHITIZATION AND PURIFICATION: Crane operator removes graphite bars from furnace bed, where they were graphitized and purified.

When you change drives...
Don't Settle for *Less* than the BEST

CONVERT TO RELIABLE R/M POLY-V® DRIVE!

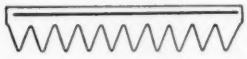




● **ELIMINATES "MATCHING" PROBLEMS**

A SINGLE UNIT across full width of sheave—NOT an assembly of SEVERAL V-BELTS

Poly-V



V-Belts

● **MORE UNIFORM POWER**
● **IN LESS SPACE**

Uninterrupted strength member full width of sheave provides higher horsepower capacity with less stretch —in less space.

● **MAINTAINS GROOVE SHAPE**
● **COMPLETE CONTACT-PRESSURE**
● **MORE CONSTANT SPEED RATIO**

Sheave grooves do not wear out of shape. Full and complete contact-pressure of rubber-to-sheave maintains groove profile. Maintains constant pitch and speed ratio.

..."MORE USE PER DOLLAR"

This gas compressor drive was rough on V-belts . . . until Wilson Supply Company installed trouble-proof R/M Poly-V Drives on all 200 HP units. Today, R/M's patented, space-saving transmission drive assures a degree of power-packed performance and dependability not possible with any available V-belt drive!

Major causes of V-drive trouble are engineered *out* of Poly-V Drive. It features a single unit, V-ribbed belt—*not* an assembly of V-belts that become unmatched and prevent complete power delivery. Full contact between Poly-V Belt ribs and specially designed sheave grooves keeps belt position constant . . . maintains groove shape and profile regardless of wear—with less wear on belt and sheaves even under toughest drive conditions! Speed ratio is unchanged. And because Poly-V Belt has uniform, uninterrupted strength member across the sheaves, Poly-V Drive will reliably deliver up to 50% *more* power in the same space as a multiple belt drive—or equal power in as little as ⅔ the space!

Let an R/M representative show you how Poly-V* Drive can give you more power delivery, more drive dependability . . . "More Use per Dollar" than the drive you now use. Just two cross sections of Poly-V Belt meet every heavy duty power requirement. Write for Bulletin M141.

WHEN YOU CHANGE DRIVES...CONVERT TO R/M POLY-V DRIVE AND BE SURE!

*Poly-V is a registered Raybestos-Manhattan trademark.

RM-954

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MANHATTAN RUBBER DIVISION — PASSAIC, NEW JERSEY

RAYBESTOS-MANHATTAN, INC.

Other R/M products: Abrasive and Diamond Wheels • Brake Blocks and Linings • Clutch Facings • Asbestos Textiles • Mechanical Packings • Engineered Plastics • Sintered Metal Products • Industrial Adhesives • Laundry Pads and Covers • Bowling Balls

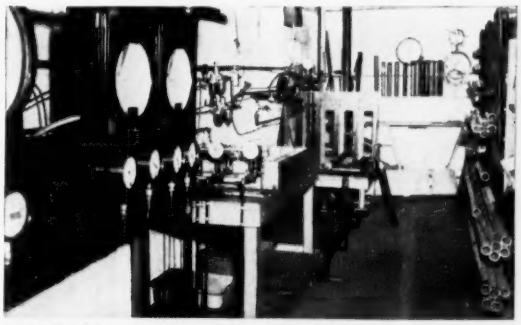
Now you can predict service life because Byers PVC Pipe Engineering brings a factual approach to piping system design

FACT: Byers PVC Pipe performance data is available on corrosion resistance, allowable stress, temperature, pressure, impact, vibration, etc., etc.

A testing program of major proportions gives substance to Byers PVC Pipe performance data. The facilities, techniques and extrapolation brought into play assure our customers predictable service life.

There are no wild claims in the Byers camp. Just facts. Many and various tests have revealed the potential for our pipe. Our recommendations are necessarily conservative. We know what our pipe can do, and would like you to share our confidence.

Since each manufacturer's PVC pipe has its own unique properties, compilation of test data is a must. An evaluation of our PVC pipe performance data will save you installation and maintenance dollars. Call a Byers field representative for details. A. M. Byers Company, Clark Building, Pittsburgh 22, Pennsylvania.



A section of the laboratory where Byers PVC Pipe runs the gamut of physical tests to determine long term pressure data. General Tire and Rubber Company's Bolta Products Division in Lawrence, Massachusetts is the site of the laboratory.

BYERS PVC PIPE

Write our Engineering Service Department for copy of this new 32-page illustrated catalog on Byers PVC Pipe.

New way to pump "dangerous" liquids safely

Goulds vertical process pump Fig. 3181 for handling highly volatile, inflammable, toxic, explosive or other dangerous liquids.

Here's a pump that *can't leak* dangerous liquids . . . *and* lets you pump at extreme temperatures.

It's Goulds Fig. 3181 tripod-mounted vertical centrifugal process pump—a new pump specially designed to handle two of your toughest jobs:

1. Lets you handle highly volatile, inflammable, toxic, explosive or other dangerous liquids *safely*. Pumpage is completely isolated from the atmosphere.

2. Lets you pump liquids at extremely low or high temperatures (minus 320° to plus 550° F.). The fluid end of the pump is well insulated from the bearings, mechanical seals, and driver and is free to expand or contract without binding or distortion.

A closed adapter and column allows the introduction of a pressurized inert gas or clear compatible liquid which isolates bearing and upper stuffing box. Proper control of gas or liquid prevents contact with outside elements.

Available in stainless steel or other corrosion-resistant metals. Capacities to 800 GPM and heads up to 300 feet.

Find out how you can pump liquids with complete safety and at extreme temperatures by contacting your nearest Goulds Pumps representative, or write for Bulletin No. 727.2.

For highly corrosive liquids GOULDS-PFAUDLER glassed pumps

Glass permanently fused to metal at all parts that contact pumpage gives you extra protection against corrosion.

Use Fig. 3182 where liquid to be handled is highly corrosive or where non-adherence or no metallic contamination is required.

Temperatures up to 350° F. on all acids except hydrofluoric. Capacities to 700 GPM, heads to 140 ft.

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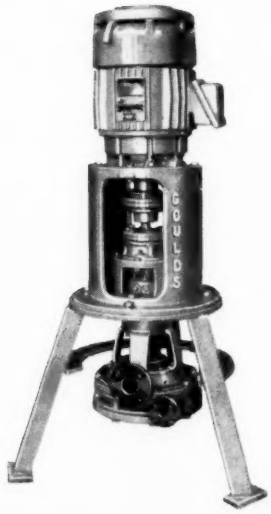

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Engineering Progress Report

FROM UNION CARBIDE CHEMICALS COMPANY

Acetonitrile boosts butylene throughput 58%, saves $3,000,000 capital investment

Unusual solvent useful in saturate-unsaturate and olefin-diolefin separations

By using acetonitrile as an extractive distillation solvent, Shell Chemical Corporation has boosted throughput of the existing butadiene feed-preparation unit 58% in their Torrance plant. Minor engineering changes for the unit cost $148,000: it has been estimated that a similar throughput increase through new construction would cost about $3,000,000. Development work and operating experience have shown that acetonitrile's unusual solvent properties should prove useful in other saturate-unsaturate and olefin-diolefin separation processes.

ADVANTAGES OF ACETONITRILE

Acetonitrile has boosted capacity in the Shell plant because it increases the spread in boiling points of the C_4 hydrocarbons being distilled. Thus, separation of the hydrocarbons is more efficient than with either acetone or furfural. Relative volatility of n-butane compared to butene-1 is about 1.25 with acetone and about 1.30 with furfural. Acetonitrile increases this ratio to almost 1.4. The spread in boiling points of butene-1 and butadiene is also increased. The table gives data on the relative volatilities of C_4 hydrocarbons in aqueous acetonitrile systems.

After the extractive distillation has been completed, acetonitrile can be completely recovered from the butane and butylene streams with greater ease than acetone. This increased recovery efficiency is due to the high distribution coefficient of acetonitrile in water/hydrocarbon systems.

ENGINEERING CHANGES MINOR

Because of the similarity of the physical properties of acetonitrile and acetone, it is not necessary to change the operating pressure of extractive distillation columns. Shell engineers made only minor changes to their unit. Besides a larger reboiler and a new pump, two heat exchangers were switched and the solvent recovery column was connected to vacuum operation. Aqueous acetonitrile systems do not foul exchanger systems. Corrosion due to hydrolysis of solvent at reboiler temperatures is minimized by pH control.

TABLE 1 RELATIVE VOLATILITIES OF THE C_4 HYDROCARBONS IN AQUEOUS ACETONITRILE, 120 psia

Component	Total Solvent Concentration, 80%m		Total Solvent Concentration, 85%m	
	Water in Solvent 15%m	Water in Solvent 25%m	Water in Solvent 15%m	Water in Solvent 25%m
Isobutane	1.638	1.673	1.637	1.674
n-Butane	1.332	1.347	1.348	1.368
Isobutylene	1.013	1.013	1.013	1.013
Butene-1	**1.000**	**1.000**	**1.000**	**1.000**
t-Butene-2	0.861	0.856	0.865	0.861
cis-Butene-2	0.821	0.813	0.827	0.820
Butadiene-1, 3	0.639	0.599	0.645	0.604
Water	0.08	0.045	0.075	0.045
Acetonitrile	0.043	0.033	0.043	0.033

OPERATING COST REDUCTIONS

The butadiene feed-preparation unit operating on acetonitrile has less solvent-loss than one operating on acetone. *Thus, solvent make-up costs are no higher with acetonitrile than with acetone.* Steam and pumping costs have also been reduced because reflux and circulation rates are lower. This is true even at reduced feed rates.

ACETONITRILE USEFUL IN OTHER PROCESSES

Acetonitrile is effective in other saturate-unsaturate and olefin-diolefin separations. This heat-stable extractant is useful in ethylene-ethane, propylene-propane, and cyclopentadiene-cyclopentane separations. The boiling point spreads between pentadienes, such as isoprene, and pentenes are also increased.

In liquid-liquid extraction processes, acetonitrile is effective in removing tars, phenols, and color bodies from hydrocarbons. Acetonitrile is also useful as a selective solvent for fatty acids.

INFORMATION AVAILABLE

If you're looking for increased efficiency in your extractive distillation or liquid-liquid extraction processes, acetonitrile could be the answer. Detailed information on acetonitrile as an extractive distillation solvent along with information on azeotropic mixtures of acetonitrile is available. For this information, call the nearest CARBIDE Technical Representative—or write, Department B, Union Carbide Chemicals Company, 30 East 42nd Street, New York 17, New York.

Nothing herein shall constitute a recommendation to practice any invention covered by any patent without permission of the patent owner.

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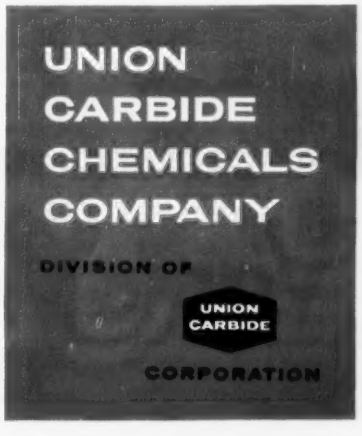

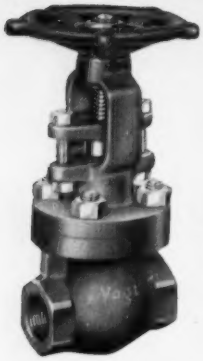

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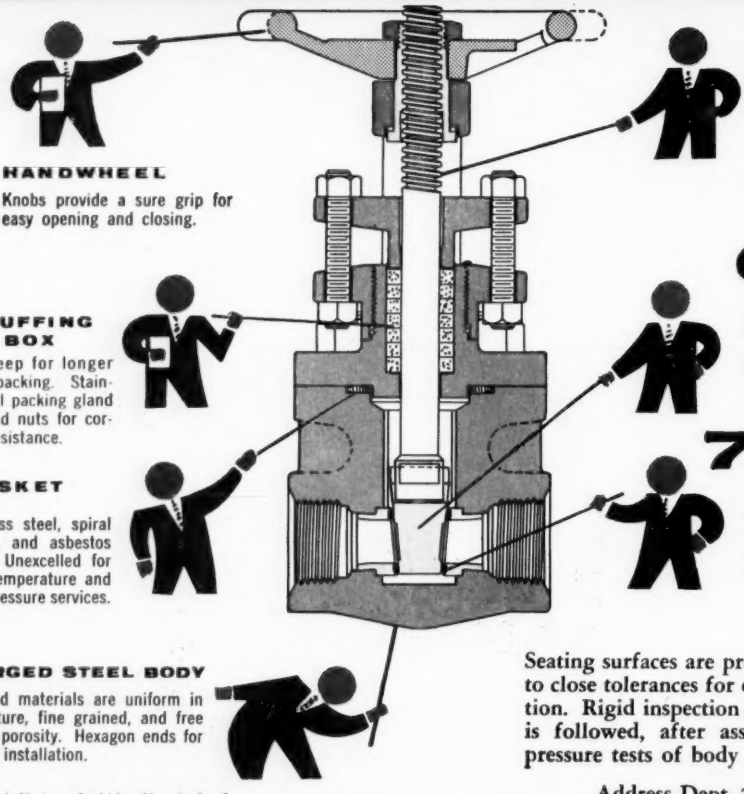

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Chemical Engineering

FEBRUARY 23, 1959

Extremely Low Temperatures

. . . Production and Commercial Uses

O. ARNOLD HANSEN, Engineering Consultant
Linde Co., Div. Union Carbide Corp., Tonawanda, N. Y.

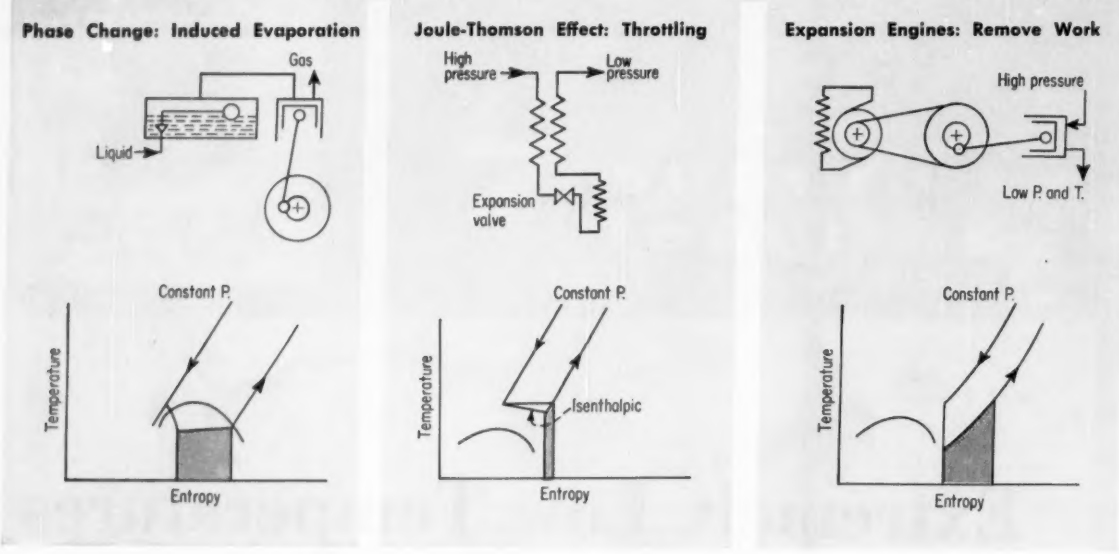
Low temperatures are always achieved by the expenditure of energy to create a condition where heat can be absorbed at low temperatures and then dissipated at a higher temperature. The simplest manifestation of cooling is by the change of phase as represented by melting ice or evaporating water. This shows only a part of the system. For a complete cycle, the water must be returned to ice and the vapor returned to water by extraction of heat. These transformations require energy to create the proper conditions for dissipating the heat at a higher temperature.

Change of phase is used to achieve very low temperatures. When liquid helium is evaporated under extremely good vacuum, a temperature of about 2 R. is obtained. Helium III has been used down to 0.5 R. This temperature represents about the minimum value that can be achieved from change of phase transformations.

For temperatures below 2 R., the magnetic properties of salts are used. The principle is somewhat analogous to change of phase. In practice, a specimen of salt is cooled to the lowest temperature possible, as by contact with helium evaporating under reduced pressure. When the salt is cold, a magnetic field is induced in the salt. This causes an alignment of the electronic spins and the dissipation of heat caused by this motion.

When this heat has been dissipated to the cooling bath, the field and thermal contact to helium are removed. The electronic spins revert to their original and in doing so, absorb an amount of heat equal to that dissipated in the alignment step. The heat can only come from the salt itself, so its temperature drops. The lowest temperature possible in this way is about 0.002 R.

Phase Change Produces Maximum Refrigeration Effect Per Unit Weight of Material, Fig. 1



Production of Cryogenic Temperatures

Refrigeration producing machinery falls generally into three types: change of phase, Joule-Thomson effect and expansion engine.

The three systems are shown schematically in physical form and on a temperature-entropy diagram in Fig. 1. Note that the phase change arrangement provides a maximum of refrigeration per unit of material. However, this system can not be used under all conditions. A specific operation may dictate that one of the other two systems or a combination of two or three arrangements may be most suitable.

How Change of Phase Works

In the change of phase system, a fluid is compressed and condensed at a high pressure, and then evaporated at a lower pressure. The heat of vaporization represents the refrigeration available for use. From the low pressure, the fluid must be re-compressed to the high pressure again. Except for those cases where there is good use made of countercurrent heat exchange between the low pressure and high pressure streams, the compression ratio becomes considerable for large temperature changes. Hence, multi-stage compression may be required.

Further, the fluid must have an appreciable density at the expanded condition to permit use of reasonably sized machines. This limits the low temperature range of the commercial refrigerants, ammonia and carbon dioxide, to temperatures above the cryogenic region. But they are widely used as the warm end of the cascade system of refrigeration.

In this system the ammonia machine, for example, supplies refrigeration at a nominal low temperature, say −60F. This refrigeration is used in the condensing portion of a second refrigeration system which uses a lower boiling fluid to operate between temperature limits in the region of −60F to −300F.

Additional steps can be used to obtain refrigeration at a lower temperature, or the two steps can be expanded in scope. By the proper selection of fluids and operating ranges, the machinery for providing refrigeration at very low temperatures can be made quite compact and efficient.

The vapor pressure of gases which may be considered cryogenic fluids when in the liquid state are shown in Fig. 2. Other physical characteristics of some of these are shown in Table I on the next page.

Difficulty of achieving cryogenic temperatures in a single stage can be demonstrated by following the carbon dioxide line from a pressure of about 70 atm. at 86F. to a pressure to 0.14 atm. at −150F. The expansion can be achieved quite readily, but the re-compression to the high pressure needed for dissipating heat at nominal temperature requires multi-stage machines. Even then the lower pressure stages would be extremely bulky.

Consider Joule-Thomson System

In the Joule-Thomson system, a compressed gas is permitted to expand through a nozzle. Under the proper temperature and pressure conditions for the gas being

handled, there will be a reduction of temperature coincident with the drop in pressure. Usually the expanded and expended gases are conducted in countercurrent heat exchange to the incoming high pressure gases. These incoming gases are cooled to lower and lower temperatures before expansion. The process can be carried to the point where there will be some liquid phase material in the nozzle discharge.

At one time, the Joule-Thomson system was used as the sole means of producing refrigeration in the cryogenic region. Now it is practically universal to combine the Joule-Thomson system with the expansion engine, and sometimes also with the conventional refrigeration system for more economical operation.

Other systems are more economical in their field, and in some cases, are essential to provide the pressure-temperature conditions for effective operation of the Joule-Thomson system. But the Joule-Thomson system has the advantage that a condensed product can be achieved directly from the nozzle.

Compare Expansion Engines

When a compressed gas is expanded in an engine, doing useful work, the temperature is reduced because of the removal of energy. The temperature reduction is greater than for the Joule-Thomson effect, making the system more efficient and better adapted to large scale work. The expansion may be from room temperature to a cryogenic temperature at the exhaust.

Generally the gas at the suction end has been cooled by heat exchange with waste gas or by a secondary phase-change refrigeration system. The expansion process is generally accomplished in a reciprocating expansion engine where the volume handled is small and the pressure ratio is great. The expansion turbine is better suited for large flow volumes and relatively low expansion ratios.

Expansion of relatively small flow volumes from high pressures of about 500 to 3,000 psi. down to pressures of 20 to 100 psi. with high enthalpy drop is most conveniently performed in reciprocating expansion engines. The maximum capacity of a single cylinder may be as much as 1,000 scfm. in commercial machines. Gas is admitted to the cylinder and discharged through timed inlet and exhaust valves, operated by outboard or overhead rockers and push rods. Valve springs are usually located on the valves, but for smaller engines may be placed within the crankcase. Expansion engines are usually single acting, although double acting engines have been used.

Flow control with expansion engines is usually obtained by varying the cut-off, which is the length of time the inlet valve is open during the expansion stroke, either by manual or automatic means. The timing of the exhaust valve usually remains fixed. In some cases, speed can also be varied. Thus, a fairly wide range of flows and pressure-ratios can be handled by a single engine. A typical indicator card for an expansion engine operating between 1,700 psi. to 75 psi. is shown in Fig. 4.

Efficiency based on actual enthalpy change compared to isentropic enthalpy change varies from 70 to 82%. This efficiency depends upon the volume handled and the pressure ratio. It is also somewhat dependent upon the maintenance of the machinery.

In the design of expansion engines, the cylinders may be made of cast stainless steel, bronze or iron, depending upon the pressure. The piston may be constructed of cast iron or bronze, using several cast iron piston rings for sealing. Metal segmented packings are usually used around the piston rod. All parts of the valve gear must be designed for impact loading. Valve and seat inserts are usually hard faced for long life.

In larger machines, steam or hot water is sometimes circulated in jackets around the piston rod packing and cylinder to insure adequate lubricant flow to the moving parts. Petroleum oil with a low pour point is used for lubrication. In smaller machines, or if lubricant can not be tolerated in the working fluid, plastic rings operating in a chrome plated cylinder may be used.

Expansion engines may be loaded either by an integral compressor pumping a fluid through a pressure ratio selected to use the available power or by shaft connection to a

Vapor Pressures of Gases Which Behave as Cryogenic Fluids

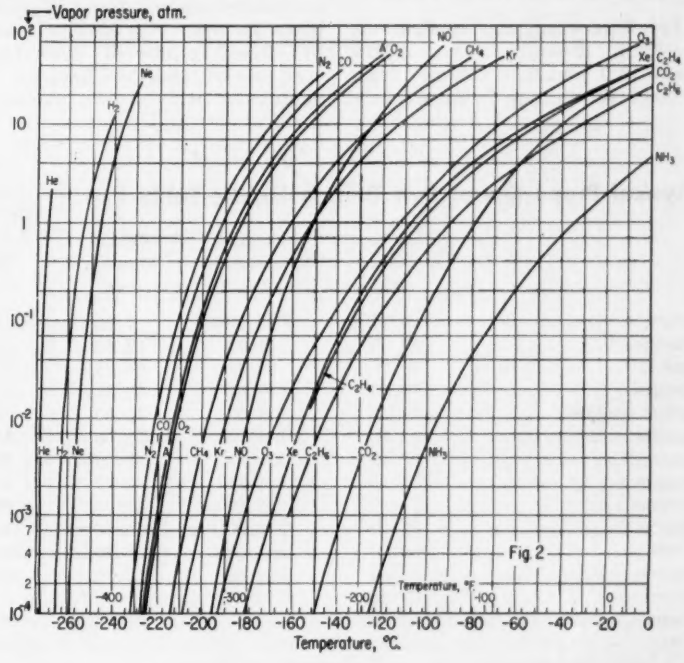


Fig. 2

separate rotating machine. Operating speeds of expansion engines are comparable to those of reciprocating compressors of the same general physical size, and range from 100 to 500 rpm. Flywheels are used as required to maintain smooth operation.

Early arrangements usually coupled the expansion engine to a single compression cylinder on the same frame. Another arrangement shown in Fig. 3 connected two expansion cylinders on one frame with two compressor cylinders on another frame by means of a common crankshaft and flywheel. More recent arrangements connect the expansion engine directly to a compressor shaft or add the expansion cylinder onto the end of a compressor cylinder driving through the same piston rod. The engine thus runs at essentially constant speed. Small expansion engines are usually built as vertical engines. These engines have cylinder diameters less than five in. They are loaded by a separate belt-driven or direct-connected machine.

Fluids handled by expansion engines include air, nitrogen, hydrogen, methane and other hydrocarbon gases. Exhaust temperatures range down to liquid hydrogen temperatures of about −432 F.

Turbines Handle Large Flows

For fluid expansion applications involving pressure ratios below about 10:1 and flow volumes from 50,000 scfh. up to more than 1,500,000 scfh., expansion turbines are usually used.

Expansion turbines are either axial flow impulse or radial inward flow reaction types. Each has its own particular advantages and disadvantages depending upon the application and operating conditions involved. Axial flow turbines may be either single or multistage while radial flow turbines are usually single stage units.

Enthalpy drop per stage is usually limited to about 20 Btu./lb. for axial turbines but may be as much as 30 Btu./lb. for the radial type. The specific speed of the turbine is computed as the product of the shaft rpm. and the shaft hp. divided by the 1.25 power of the isentropic head measured in ft.-lb./lb.

For the axial turbine, the specific speed is between 10 and 25 while for the radial turbine the value is between 20 and 40. However, the specific speed is seldom sufficient to determine the preferred type to use for any particular application.

For impulse turbines, flow control is usually achieved by valves which shut off the flow through individual nozzles or groups of nozzles to give a wide range of flow control. These turbines are normally loaded by an induction generator through conventional reduction gearing, and thus run at essentially constant speed. However, these turbines may also be loaded by direct connected centrifugal compressors, and thus have the advantage of being able to operate at variable speed to obtain good efficiency.

Impulse turbines may be arranged either for outboard bearings, or have the turbine wheel overhung from the adjacent bearing. In either arrangement, it is necessary to provide seals around the shaft to prevent leakage of cold gas into the bearings and subsequent freezing of the oil.

Type of seal is influenced by the economic value of the fluid being handled. Low-temperature fluids are valuable, since considerable power has been previously expended to attain the low temperature. For extremely low seal-leakage, an inexpensive secondary sealing fluid such as air or nitrogen is used as a buffer gas. The secondary sealing fluid must be dry to prevent ice formation within the seal.

Materials of Construction

Materials used in turbine construction for the various components are:

- Turbine casing: cast iron or bronze.
- Shaft: stainless steel.
- Wheels: stainless steel or aluminum.
- Blading: stainless steel or aluminum.

Castings which are subjected to low temperature should be stress relieved to contribute to dimensional stability and to avoid locked-in stresses. Babbitt lined sleeve-type bearings are usually used and may be either solid or

Physical Properties of Low Boiling Fluids—Table I

	Boiling Point at 1 Atm., °K.	Critical Temperature, °K.	Critical Pressure, Atm.	Freezing Point, °K.	Density Liquid* G./cc.	Density Gas** G./l.	Heat of Vaporization G.-cal./g.
Helium	4.26	5.29	2.26	<0.80	0.125	0.178	5.20
Hydrogen	20.43	33.22	12.80	13.99	0.071	0.090	107.00
Neon	27.21	44.42	26.85	24.44	1.202	0.900	20.70
Nitrogen	77.35	126.00	33.50	63.27	0.807	1.250	47.00
Carbon monoxide	81.10	134.00	35.00	74.00	0.803	1.250	51.56
Fluorine	85.02	144.00	55.00	53.54	1.100	1.700	41.20
Argon	87.40	150.70	48.00	83.83	1.390	1.780	37.90
Oxygen	90.13	154.31	49.71	54.73	1.140	1.430	51.00
Methane	111.70	190.60	45.80	89.90	0.420	0.720	
Krypton	120.20	210.50	54.30	116.50	2.400	3.730	
Xenon	166.00	289.60	58.20	161.60	3.060	5.890	
Ethylene	169.40	282.80	50.90	103.70	0.570	1.260	
Deuterium	23.60						75.60
Ozone	161.00						71.00

* Liquid density at boiling point. ** Gas density at 273 K.

split design. The latter is preferred for ease of maintenance. However, design considerations often require solid bearings.

Turbines designed and constructed in the manner described have been shown to be economical and quite reliable. Also, they are relatively insensitive to erosion damage resulting from operation in the liquid region. Typical performance curves are shown in Fig. 6. However, the chief disadvantage of axial impulse expansion turbines is that the efficiency is generally somewhat lower than that attainable with radial reaction type expansion turbines.

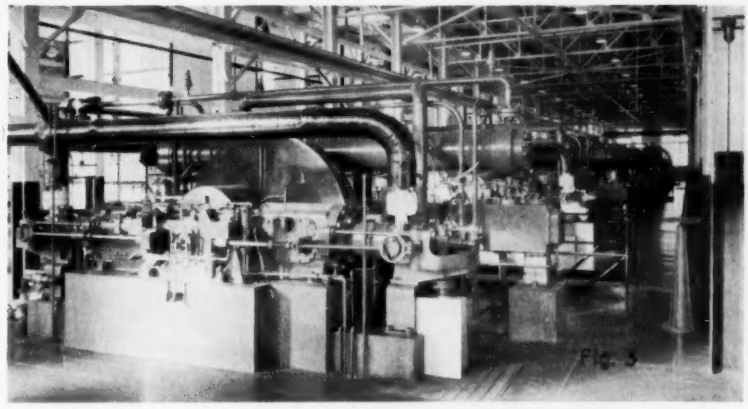
Radial reaction turbines were first used commercially for refrigeration purposes in the United States about 1948, and are used in preference to the axial impulse type. A typical radial turbine with an integral two-stage compressor for absorbing the power is shown in Fig. 5. Their higher efficiency is due to simpler hydraulic design.

They are arranged to have about 50% of the pressure drop occur in fixed nozzles and the remainder in the passages of the wheel. This arrangement results in higher rotative speeds for a particular design condition than for the impulse type turbine. Thus, the rotative speed may for small radial reaction turbines, be from 20,000 to 60,000 rpm. For this reason, radial reaction turbines are usually loaded with air blowers or oil pumps without recovery of useful work. This loss is not serious, as the process value of the higher turbine efficiency outweighs the relatively small shaft power loss.

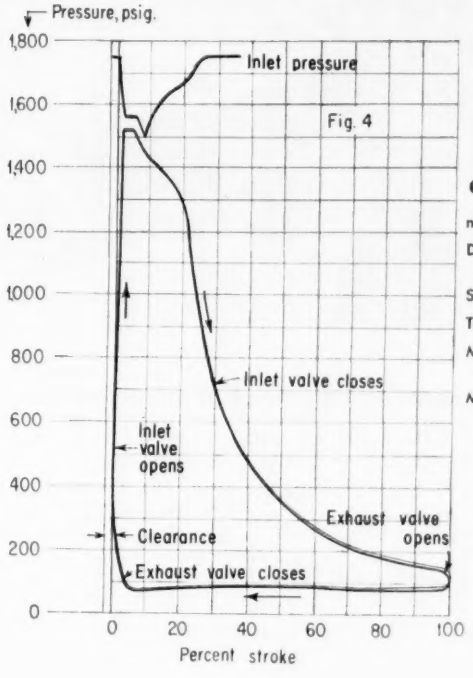
However, larger radial reaction turbines with speeds of 15,000 to 20,000 rpm. may be loaded by electric generators through reduction gearing or by direct-connected centrifugal compressors. Either of these permits the recovery of useful shaft work, which may amount to up to 15% of the cycle power for some processes. In gaseous oxygen producing plants, power returned by the expansion turbine is about 5% of the plant power.

Flow control of radial turbines is usually obtained by inlet throttling or by variable area nozzles. Control of radial turbines by shutting off some of the nozzles has not been used by manufacturers in this country because of the resultant loss in efficiency at lower flow rates.

Common Crankshaft Connects Expansion Engine to Compressor



Indicator Card for Reciprocating Expansion Engine



Operating Conditions

Inlet temperature	−47 F.
Discharge temperature	−265 F.
Speed	137 rpm
Thermal efficiency	82%
Mean effective pressure	490 psig.
Mechanical efficiency	60%

To limit the heat transmitted to the process fluid, the turbine casing is insulated from the bearing assembly by supporting arms having low thermal conductivity. Other mechanically-limited heat paths may also be used.

The turbine is enclosed within a removable metal casing and is insulated with a bulk material such as glass wool. Thus, the running equipment can be made accessible for inspection and maintenance purposes. Powder insulation is not recommended because it might get into the turbine oil and be carried to the bearings.

Materials used in radial turbines are about the same as for impulse turbines, except that aluminum alloys are usually preferred for rotating parts. Aluminum alloys are

Radial Expansion Turbine Powers Two-Stage Compressor

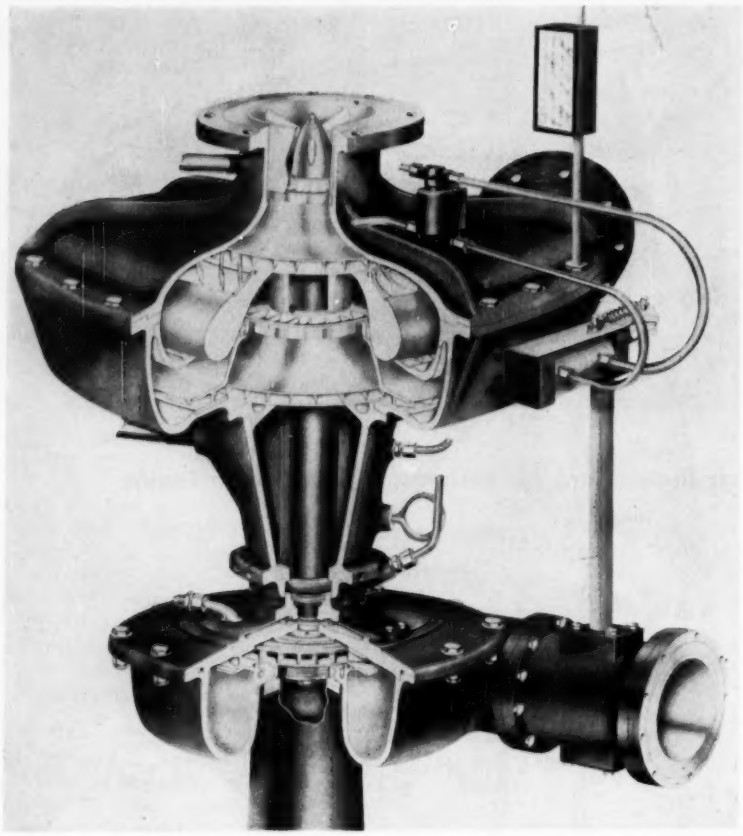
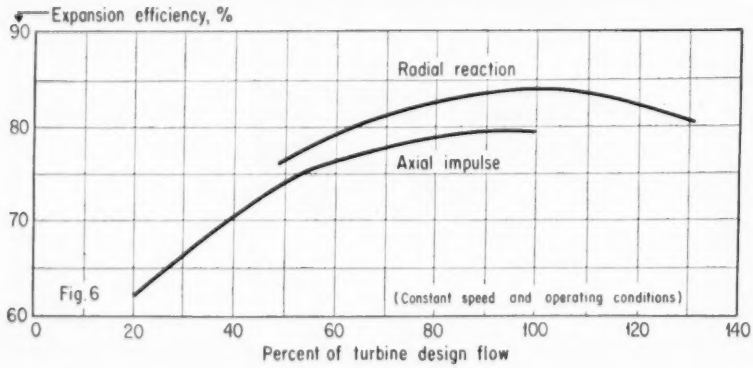


Fig. 5

Efficiency of Radial Reaction and Axial Impulse Turbines



much lighter than stainless steels and have a higher strength to weight ratio which permits high tip speeds. The light wheel permits smaller shafts and thus facilitates bearing and seal design. Also, aluminum alloys can be cast with very smooth surfaces and small dimensional tolerances.

Due to the small clearance required in radial turbines for high efficiencies, it is necessary that the process gas be clean. Fine mesh screens or filters are used at the turbine inlet to remove all solid particles. Low pressure drop is necessary in order that the fullest use can be made of the total pressure drop available.

Radial turbines are susceptible to damage by erosion of wheel tip and nozzle exit surfaces if operated with liquid in the exhaust stream. Operation in the liquid region is to be avoided, not only because of the erosion but also because of the loss in efficiency. While it is difficult to obtain quantitative data, this loss may be about 1% for each percentage of liquid in the exhaust. Also, except for some special fluids and processes there is no thermodynamic reason for operation below the saturation line.

Probably the most widespread use of expansion engines and turbines is in the production of liquid oxygen and nitrogen, both of which require refrigeration down to liquid air temperatures. For liquid oxygen and nitrogen production, high pressure cycles operating at about 2,000 psi. head pressure are used with expansion engines. For gaseous oxygen and nitrogen plants, head pressures usually range from 80 to 100 psig. and expansion turbines are almost invariably used.

Measuring Low Temperatures

Basic instruments for measuring low temperatures are vapor-pressure and gas-filled thermometers. These may be used down to about 2R. The vapor pressure thermometer has the disadvantage that the scale is far from linear, being much less sensitive at very low temperatures. The gas filled thermometer, especially when helium filled, has a very nearly linear scale, but even so, the measurement of the pressure at the 2 R. region is difficult.

Helium vapor-pressure and gas-filled thermometers are reliable standards, but they are difficult to use to measure the temperature of other than liquids. The secondary thermometers used for measuring temperatures of solids are generally of the resistor type, thermocouple type or for very low temperatures, the magnetic susceptibility type.

The platinum resistance thermometer has generally good characteristics for measuring temperatures down to about 2 R. but the sensitivity is not good at the very low values. However, the instru-

ment can be readily calibrated and holds its calibration well for general work. For highly accurate work, even the platinum resistance thermometer must be recalibrated frequently.

Metals other than platinum can be used as a resistance thermometer. Some metals have advantages in certain temperature ranges or applications. However, the other metals are not so easily reproducible as the pure platinum unit. Hence, results must be correlated with on-the-spot calibrations against a standard gas-filled or vapor-pressure thermometer.

The carbon resistance thermometer is interesting in that it operates on reversed thermal coefficient of resistivity. That is, in this region, the resistance increases as the temperature is reduced. At about 2 R., however, the total resistance is so high that sensitivity and accuracy fall off. An advantage of the carbon resistance thermometer is the low cost and the ease of measuring the temperature at the surface of a solid. In this latter case, the thermometer can be constructed of a film of carbon particles from a Dag suspension laid over an insulating film which is attached to the surface under test.

The conventional thermocouple can be used at low temperatures, but the behavior is affected by the choice of materials. At the very low temperature some of the metals may develop the characteristics of super-conductivity and reverse resistance coefficient. A quite reliable combination is gold alloyed with 2.1% cobalt used with Constantan.

At temperatures below 2 R., the temperature measurements are obtained by the determination of the magnetic susceptibility of a salt. The temperatures below 2 R. are best achieved by cooling a salt, magnetizing it while it is held at a very low temperature, and then removing the magnetic field.

The salt loses its magnetism only when heat is added or when it obtains the heat from itself and so cools itself. Hence, magnetic susceptibility is in equilibrium with its temperature. These temperatures are always written T^* and are obtained from extrapolations of helium gas thermometer indications. Although the temperatures are not accepted as standard, they are definitely comparative and fill the need.

Applications of Low Temperatures

Very low temperatures of cryogenics are used for separation of components, or for extreme retardation of chemical or physical processes. It is in the first of these that most experience has been gained. Oxygen has been made by distillation of liquid air since the turn of the century. Knowledge gained in oxygen separation has been extrapolated into new fields.

Cryogenic processes are used to separate constituents of gases in the petrochemical industry, to provide for recovery of helium from natural gas, and to separate and to provide cryogenic fluids for maintenance of low temperatures.

Atmospheric Gas Separations

Separation of oxygen from air by liquefaction and distillation was introduced in this country in 1907. The refrigeration was obtained completely from the Joule-Thomson effect of expanding air which had been precooled by countercurrent heat exchange with the exit streams of oxygen and nitrogen. Later modifications of the cycle used expansion engines to achieve part or all of the refrigeration. Thereby more of the product could be removed as liquid.

Distillation in the oxygen industry is generally carried out in a double column as shown schematically in Fig. 7. Note that the lower column functions principally to obtain a high-purity nitrogen liquid for reflux in the upper column. Nitrogen condensing in the lower column supplies heat for the lower portion of the upper column.

Although this equipment operates basically to separate oxygen and nitrogen, it also serves to concentrate all the rare gases where they can be collected. For example, argon tends to remain with the liquid oxygen in the upper column. It is most concentrated at about half way between top and bottom, so an argon rich mixture at that level can be drawn off and the argon separated.

Argon drawn off the upper column is diluted with both oxygen and nitrogen. The nitrogen can quite readily be removed by distillation, leaving an argon-oxygen solution. Oxygen can be removed by combustion and removal of combustion products or by selective adsorption on Molecular Sieves. (U. S. Pat. 2,810,454)

Molecular Sieves are synthetic crystalline zeolites having pores of closely controlled sizes. Linde type 4A has pores which admit molecules of diameters less than four angstrom units but will not admit larger molecules. Accordingly, a gas stream passing through a bed of this material will be separated into two constituents. Those molecules less than four angstrom units in diameter collect within the pores of the sieve and all larger molecules pass through unhindered.

Since the oxygen molecule is small, all the oxygen will be adsorbed in the sieve and pure argon will pass out from the bed. The bed has tremendous capacity for oxygen. The maximum amount is 17% by weight under static conditions of atmospheric pressure and liquid oxygen temperature. Under flow conditions, the material will absorb up to 10% of its weight of oxygen at a superficial contact time of 30 sec. and the same conditions.

In commercial practice, the gas is passed through two beds in series. When the first bed is saturated with oxygen, it is removed from the system for reactivation and the second bed becomes the first bed in a new series of two beds. This assures complete removal of oxygen, since the second bed is always one with high adsorpion capacity.

Reactivation is accomplished by heating the bed to about 190 F. with a flow of dry nitrogen gas passing through the bed to equalize temperature and to purge the bed of oxygen. Nitrogen is then purged from the bed using warm dry argon.

After the argon purge, the bed is pressurized with helium and cooled to operating temperature of about −360 F. Helium gas has high thermal conductivity which aids in cooling down the bed. Also, helium can be purged easily from the cold bed by cold argon. The bed is now ready for use as the second of the two used in series.

Note that all purge gases must be dry. The Molecular Sieve is a very good desiccant and the presence of moisture interferes with the absorption of oxygen. To reactivate the sieve after contamination with water requires heating and purg-

Double Column Distills Liquid Air

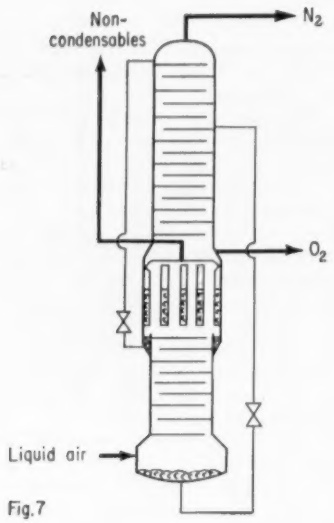


Fig.7

ing with nitrogen at 650 F. The sieve is not adversely affected by the high temperature reactivation.

Krypton and xenon are contained in the liquid oxygen of the main condenser in very minute concentrations. They are recovered by concentrating in a separate column from which a small stream of oxygen rich rare gas is removed. This product is refined by differential adsorption to get the pure product.

Other rare gases, neon, helium and hydrogen, have boiling points lower than nitrogen so they do not condense in the lower column. For continuous operation of the condenser, it is necessary to bleed off the non-condensables. These can be separated to obtain the particular rare gas desired. These separations are obtained either by distillation or by selective adsorption on activated charcoal or other adsorbent.

Liquified Gas Products

The most common liquid hydrocarbon in the cryogenic region is methane. Much of the natural gas of the world is methane, and it exists as a gas under quite high pressure. Pipelines make it available in wide areas, but the cost of the pipeline and the several pumping stations makes even such shipment quite expensive.

In a new development, it is suggested that the high pressure methane at the gas field be liquefied by expansion through engines or turbines or both. Re-compression and re-expansion of that portion not liquefied on the first pass is necessary. Liquid methane can then be shipped by barge or boat to a point of use. Power for propulsion can be obtained from the methane which evaporates because of heat leak through the insulation. This technique eliminates the economic problem of maintaining the insulation in top-notch condition.

Whether or not the refrigeration will be utilized at the point of use depends upon economic factors. For shipment from Texas to Chicago, for instance, the competition of existing pipelines makes such utilization necessary. Accordingly, the best point of use at Chicago will be adjacent to the stockyards where there is a good market for large amounts of refrigeration.

However, where methane is shipped from Texas to Great Britain, the competition from pipelines is absent. Here application is not limited to areas where the refrigeration can be utilized. Because of the high cost of competitive fuel gases, the refrigeration need not be utilized to make the system economical.

Low temperature fractional condensation and distillation are often used to recover heavier components of natural gas. These components may be used as raw materials for the production of many chemicals. The same principle is used to remove methane from hydrogen-methane mixtures so the pure hydrogen can be used in chemical reactions.

Coke oven gas has been separated into its constituents by low temperature techniques for many years. First used extensively in Europe, the practice is growing in this country. The process permits the separation and recovery of ethylene and propylene for use as raw materials in the chemical industry. It also provides for the separation of hydrogen and for the upgrading of residual gas for steel making purposes.

Hydrogen from coke oven gas is frequently used for the production of ammonia. In this case, a liquid nitrogen wash is usually used to remove the impurities, especially carbon monoxide. This impurity is otherwise difficult to remove since its boiling point is almost as low as that of nitrogen.

The Linde Co. has recently developed a new process for the purification of hydrogen. This process does not require the liquid nitrogen wash and so eliminates nitrogen contamination. Accordingly, it permits production of hydrogen of any desired purity.

Methods have been worked out for the removal of methane and other hydrocarbons from complex mixtures to provide a synthesis gas for methanol production and for the OXO process. Carbon monoxide recovery and purification can be handled well by low temperature fractionation. Several such plants are in operation.

Moderately low temperatures are used where large amounts of carbon dioxide must be removed as from hydrogen produced by the water-gas shift process. Cold acetone or methanol are used as solvents to free the gas streams from carbon dioxide, hydrogen sulfide and a number of trace impurities among which may be a variety of hydrocarbons.

Helium Separation

Helium is separated from the other gas constituents by refrigeration and fractional condensation. Because of the extremely low boiling point of helium, it can be separated quite readily. However, the low concentration in the feed gas makes it necessary to handle large quantities of material. Because all of this material must be cooled to extremely low temperatures, the heat exchangers and insulation must be efficient to keep the power costs low.

Gas Purification

Removal of impurities from gases is made easier when the product is at cryogenic temperature. In this region, the materials are liquids and generally separation can be accomplished by distillation. This is a preferred method, since the process can be a continuous one.

An example of distillation for purification is the method for preparing pure argon. Oxygen in the crude argon is burned to water in an excess of hydrogen. After the water is removed, the resulting argon-nitrogen-hydrogen mixture is liquefied and distilled. The relatively wide difference of boiling points makes the distillation simple and effective. The low temperature

of the distillation also insures the absence of moisture in the argon.

Where gas purification is carried out by selective adsorption rather than by distillation, the process is usually carried out at cryogenic temperatures. At these low temperatures, the amount of constituent adsorbed is at a maximum, and generally the selectivity of the adsorbent is improved. Also, the gases can be pumped to high pressures by adsorbing at low temperatures and desorbing at high temperatures.

Purification of xenon from a crude product of xenon and krypton is carried out by using activated carbon at −148 F. to selectively adsorb the xenon. Carbon adsorbs both gases in some measure but the selectivity is more apparent as the amount of gas adsorbed increases.

At the start of the cycle, both gases are adsorbed and there is no effluent. As the process continues, the xenon in the incoming gas displaces the adsorbed krypton. Hence the effluent is pure krypton. When most of the carbon bed is saturated with xenon, the last part of the bed can not remove all the xenon from the incoming gas. Some of the xenon then passes out with the krypton. This is recovered separately for a subsequent run during the second phase.

The second part of the process is carried on to the point where the outlet products show only traces of krypton in a high concentration of xenon. This indicates displacement of all adsorbed krypton so the third phase, the recovery of xenon, is started.

Xenon is recovered by warming the carbon bed and venting the gas to a vessel submerged in liquid nitrogen. Xenon condenses and freezes solid in this vessel. Xenon can be transferred to a pressure cylinder by warming the vessel. The activated carbon bed is then ready for a repeat cycle.

Liquid Helium and Hydrogen

Liquid helium and hydrogen are valuable because of their extreme low temperature and their unique properties. Liquid helium temperature closely approaches absolute zero, even when the material is at a pressure of one atmosphere absolute. The material can be used in the gas-liquid phase change for production of refrigeration at extremely low temperatures. For example, the liquefaction of hydrogen can be accomplished by heat transfer with liquid helium which is the working fluid in an extreme low temperature cycle. The liquid hydrogen can be used effectively in high specific impulse rockets.

Hydrogen when liquefied contains a large portion of orthohydrogen, an unstable form, which is transformed to parahydrogen with the liberation of considerable heat. Hence, the refrigeration needed for producing stable liquid hydrogen exceeds that for liquefaction only.

Hydrogen gas at room temperature contains about 25% parahydrogen and 75% orthohydrogen. In parahydrogen, the two atoms of the molecule spin in opposite directions while in orthodydrogen the atoms spin in the same direction.

When liquefied, the same ratio exists but at low temperatures this ratio is not stable. Orthohydrogen tends to change to parahydrogen until the ratio becomes 99.8% parahydrogen and 0.2% orthohydrogen at the boiling point of hydrogen which is −423 F.

Change from orthohydrogen to parahydrogen is quite rapid when the concentration of orthohydrogen is high but slows down as the state of equilibrium is approached. After 30 days storage, the residual liquid will be upgraded from its original value of 25% to a new value of 90% parahydrogen.

During the transformation, the process generates enough heat to evaporate 64% of the original liquid. By use of a catalyst, this change can be effected during the liquefaction process. Hence a stable parahydrogen will be produced for storage without loss from self-generated heat.

A most effective catalyst for this conversion is hydrous ferric oxide. The oxide is produced from ferric hydroxide gel to give a hard, strong product with extremely large surface area and high magnetic susceptibility.

The catalyst operates in two ways. The strong magnetic field at the several points of the catalyst structure tends to unbalance the unstable equilibrium of the molecular spin in the orthohydrogen. This effect changes the orthohydrogen to the parahydrogen form. At the same time the large surface area assists in molecular dissociation and re-combination. Re-combination yields predominantly the more stable parahydrogen.

Biological Processes

All biological processes are slowed down by lower temperatures, and the lower the temperature the lower the biological activity. Thus, the biological processes which are retarded more effectively by a freezer than by a refrigerator are retarded even much more effectively at cryogenic temperatures. There is some reason to believe that biological activity goes into a state of suspended animation at the temperature of liquid nitrogen. This makes it possible to preserve living biological material for use or for test for indeterminate lengths, thus opening up new fields of tremendous importance.

An interesting adaptation of cryogenic slow-down of biological processes is that of very deeply freezing foodstuffs and then shipping these products in well insulated wrappers to the point of use. Because of the very low temperature, it is possible for considerable heat to leak through the insulation before the foodstuff becomes so warm that the food may suffer damage.

Shipments have been made from New York to Venezuela by boat. The products arrive so cold that it was possible to break up the large package and trans-ship parts of the load to even more distant points without intermediate refrigeration.

Metal Treatment

Low-temperature soaking is now being used to enhance the dimensional stability of several types of metal castings. Preliminary research has shown that desirable mechanical properties can be achieved through cold working some metals at temperatures down to liquid nitrogen. For example, stainless steel sheet may be hardened by a 10% reduction in thickness at nitrogen temeprature to the same hardness level as is associated with a 60% reduction at room temeprature.

As our need for better control in the properties of constructional materials increases, these and other phenomena may move from the research laboratory into a new and growing segment of United States and world industry.

Equipment Needs for Low Temperatures

Principal reason for using the low temperatures of cryogenics is that these temperatures have an effect on materials. But these effects can apply to the containers and other apparatus as well as to the material in question. Accordingly, containers and apparatus must be designed with these considerations in mind.

Cryogenic Insulation

Heat leak is carried through insulation by conduction, convection, and by radiation. At cryogenic temperatures, the thermal gradient to ambient is considerable, the cost of refrigeration is high, and the loss of cryogenic fluid becomes greater the lower the temperature. Accordingly, the best possible insulation is required. This is achieved by providing the maximum hindrance to heat flow.

For conduction, the best insulation can be achieved by a good vacuum. The common vacuum-insulated Dewar flask is an example which provides generally effective insulation.

But whereas the loss from conduction can be minimized, the loss from radiation remains. And with conventional Dewar construction, the best that can be done is to make the inner face of the casing and the outer surface of the container as highly reflective as possible. Additional radiation shields are difficult to support without introducing conductive heat transfer from the wall which supports the shield.

Convective heat transfer can be eliminated by high evacuation, as for conduction. With high vacuum then, the heat transfer is mostly by radiation. Heat transfer from this source varies as the difference of the fourth powers in absolute temperature. While the values are not considerable at very low temperatures, the economic cost is considerable. Accordingly, good insulations for cryogenic work use vacuum as a matter of course, and in addition, such means as can be devised for reducing radiation. These devices are usually based on metal shields or fine powders.

In a very fine powder, the particles have very small diameters and extreme surface curvatures. In fact, the surface of the particles can be considered to be pointed in all directions. Hence, the separate particles have only point contact, with each other. Conduction, then, will be very small since it is a function of the cross-sectional area path provided for heat flow.

The particles are partially reflective and partially absorbtive of heat rays. Even where they are absorbtive, they hinder heat flow because they emit heat at a lower level than at which they absorb it. Where the particles are reflective, they act as miniature reflective shields.

Where the insulation powder is transparent to heat waves or is not reflective, powder insulation can be improved by adding a reflective medium. Aluminum or copper flakes can be intermixed with the powder to obtain a better insulation even though the metal powders may provide miniature conductive short circuits in the insulation.

For effectiveness, metal powders must be extremely fine so the length of the short circuit is not appreciable. Also, the particles must be so well mixed that the metal particles can not bridge. It is interesting to note that this insulation may be considered as a high vacuum insulation with a discontinuous metal powder radiation shield supported on an insulating powder.

Metallic shields are sometimes inserted into the vacuum space for decreasing radiation heat transfer. In a modification of this, a solid metal radiation shield is converted to a thermal shield. Gaseous product evaporated from the cryogenic fluid is passed through a tube in thermal contact with the thermal shield. Without a thermal shield, the temperature in the insulation is nearly a linear function with the position between the two walls.

With a single thermal shield, the insulation becomes, in effect, two insulations with a large temperature difference to the thermal shield and a smaller difference of temeprature between the shield and the inner container. The sensible heat of the vented gases acts to subcool the thermal shield so there is a small temperature difference between it and the liquid container.

Two arrangements of thermal shields are shown in Fig. 8. Note that where no shield is used the temperature gradient through the insulation is shown as a straight line. This would be achieved with an insulation whose conductivity is not effected by temperature and where the same quantity of heat passes through the entire thickness.

Thermal Shield Minimizes Heat Flow Through Wall of Vessel Containing Cryogenic Liquid

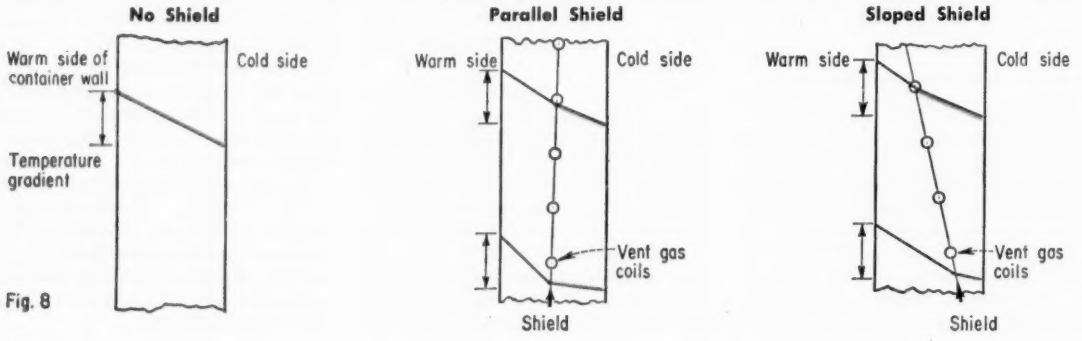
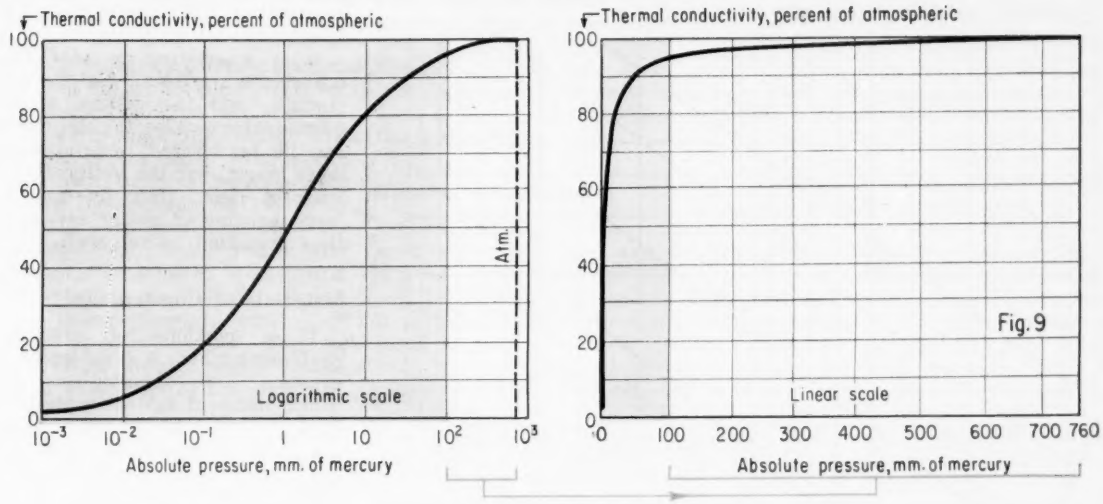


Fig. 8

Very Low Pressures Greatly Improve Insulating Properties of Fine Powders



Where a parallel shield chilled by the gas from the cryogenic fluid is used, the shield is very effective where the gas enters and less effective as the gas products warm up. Where the gas enters, the shield chills the insulation some distance from the cold side and so makes an easy temperature gradient to the cold side. But the temperature gradient between the warm side and the shield is great. In this case, heat flow to the shield is rapid. This warms the gas in the shield so subsequent cooling is not as effective.

Another arrangement uses a sloped shield with the cold end of the shield located nearer the cryogenic vessel. The sloped shield is mildly effective over its entire area.

Where the cryogenic fluid is very expensive, losses are reduced or eliminated by using refrigerating fluid in a double walled vessel. In the first case, the thermal shield is provided with considerable liquid holding capacity. Within this is constructed a well-insulated vessel. Since the temperature gradient through this insulation is not considerable, the heat transmission to the innermost container will be kept at a low value.

In other arrangements, the liquid container proper is made double-walled, and a less expensive cryogenic fluid is used in the wall space. The fluid in the wall space is vented to the atmosphere, or may be evacuated. The inner vessel is sealed and even pressurized. Under equilibrium conditions, both fluids will be at the boiling point, but only the material in the jacket is lost.

A common denominator for all good insulations is a vacuum. The most economical degree of vacuum is different for different fillers. In all cases, the vacuum is of a much higher order than is normally used except in the electronic industry. The absolute pressure is read in microns of mercury. One micron is equivalent to 0.001 mm.

For the most common powder-vacuum insulation, the absolute pressure is kept in the range of 100 microns. This vacuum is obtained with a positive displacement mechanical pump. The clearances are low and an excess of lubricant is fed to the machine so the pump will operate even at the extremely high compression ratios obtained when low absolute pressure suction conditions exist.

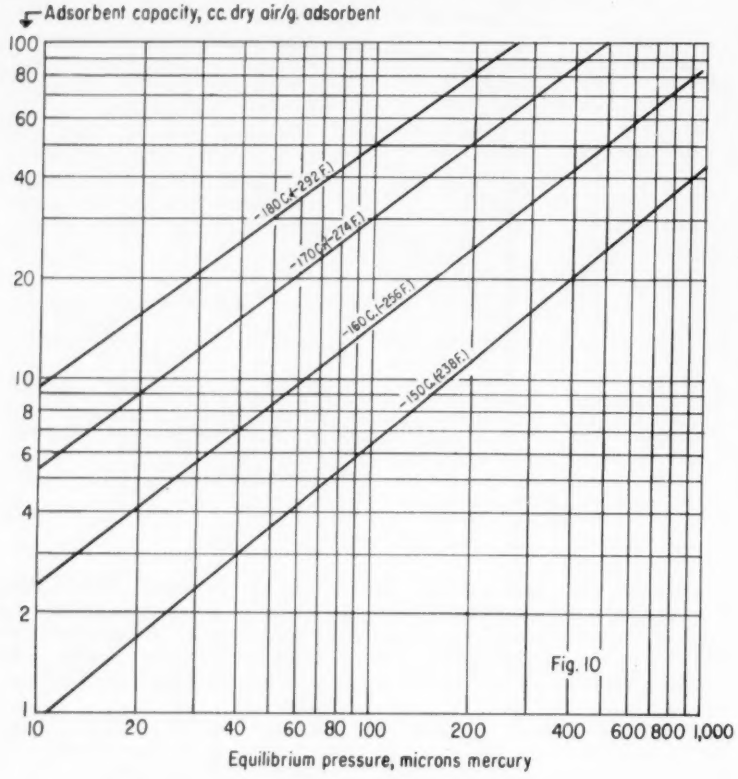
Because of the large amount of lubricant fed into the pump suction at each stroke, it is imperative that the lubricant be kept free of volatile contaminants. Of these contaminants, water is the most prevalent and is the most troublesome. It is removed from the surface of the powder particles when the pressure is reduced to about 5,000 microns. Water is kept from interfering with evacuation by removing it from the lubricant. This is done by bubbling a dry gas through the lubricant supply. Atmospheric air handled by the vacuum pump itself is used in a modification called gas-ballast.

Effect of vacuum on the insulating properties of fine powders in cryogenic work is shown in Fig. 9. The linear scale in the figure dramatizes the improvement obtained at the very low pressures. There appears to be a leveling-off effect at the very low pressures. For different insulating powders, the shape of the curve and the leveling-off point are different.

If a powder insulation is evacuated for some time, practically all of the inert gases are removed. The inert gases are swept out by the water vapor being removed from the insulation. Then when the apparatus is cooled down, the remaining water vapor is condensed on the cold surface, giving a good vacuum throughout. This principle has been suggested as an alternate to the pump—a purge of the space with a condensable gas, followed by condensation of that gas on the cold portion of the apparatus.

Ability of a cold surface to improve the vacuum by condensing some of the vapor constituents can be enhanced many times by using an adsorbent. Activated charcoal has been used for many years, but new synthetic materials are more effective. These materials are

Low Temperatures Increase Capacity of Molecular Sieves



crystalline zeolites which have the property of adsorbing gases. Adsorbtive capacity increases at very low temperatures as shown in Fig. 10.

The material is usually maintained as a shallow bed directly in contact with the cold portion of the apparatus. Because of the tremendous adsorbtive capacity at low temperature and pressure, the adsorbent causes a marked immediate improvement of vacuum, and retains that vacuum over long periods. Any leakage into the insulation space travels to the adsorbent where it is captured and held with a very minimum pressure rise.

Where the quality of the powder is improved, these insulation values can best be developed when the vacuum is made more nearly perfect. These extremely low pressures are achieved by using a diffusion pump as a first stage for the conventional vacuum pump. In addition, the insulation and apparatus is generally heated to assist in removing the gas adsorbed on the walls and on the insulation particles. When a good vacuum is achieved, the same adsorbent previously discussed acts to preserve the vacuum in spite of small leaks. At these very low pressures, maintaining minimum leakage becomes increasingly important because of the limited capacity of the adsorbent.

Where reflective shields are the principal barrier to heat transfer, the vacuum must approach perfection. The difference in performance is very noticeable when the vacuum changes from 0.01 micron to 0.1 micron. These very low vacuums are obtained using the diffusion pump-mechanical pump system as for the insulation discussed above.

In addition, a clean-up step is employed. The small amount of residual gas is removed by chemically uniting it with a getter. Elemental barium is quite effective as a getter and is most effective in very thin sheets. Zirconium metal is also used but must be heated to be effective. Accordingly, the zirconium type vessel is fitted with heating means for periodic reactivation while the barium type is operative at all times.

It is interesting to note that adsorbents are installed at the cold surfaces and the getters at the warm surfaces. Also, the adsorbents can be reactivated by evacuation when warm, but the getters are a one-shot item. Only by using a large amount of getter can long-time operation be achieved.

Materials of Construction

Those portions of cryogenic equipment which are subjected to extreme low temperatures are usually made of austenitic stainless steel. Copper and aluminum alloys are used for special purposes, but the stronger, more nearly leak-tight joints which can be made in stainless steel make it preferable.

Normal steels and even the straight chromium stainless steels can not safely be used. These materials display a strong tendency towards notch-sensitivity at low temperatures. As a consequence, any stress raiser even an inclusion in a weld may serve as a starting point for failure. The material would fail into several pieces, giving every evidence of a brittle fracture. The very low impact strength of mild carbon steel is shown in Table II.

A welded joint in stainless steel is the most likely to be leak-tight. Welded joints in aluminum are somewhat more difficult to make with the high order of leak-tightness required. Copper alloy joints are usually silver brazed rather than soft soldered to obtain better leak-tightness, and to provide a greater measure of safety.

Plastics are generally used only as supports, but they serve well here because of their low thermal conductivity. Unreliability of high strength adhesives at low temperature limits the use of plastics to compression type supports. Here the low unit strength compared to metal is not so marked, because a thick section is preferred to avoid failure by buckling.

Supports for the inner container of a well-insulated vessel contribute to the heat transmission to that container. The better the insulation, the more important, relatively, becomes heat transmission through the supports. Hence, sup-

ports are commonly of the tension type using materials which have the desirable combination of high strength and low thermal conductivity. Austenitic stainless steels are well suited for this work but are excelled by some special alloys.

Supports must provide for fixed location of the parts when warm and when cold, in spite of the thermal contraction of the inner container. In small vessels, this can be done by using the natural elastic deformation of the supports and vessel to avoid high stresses.

In larger vessels, some other means of compensation must be provided to prevent undue straining of some part of the structure. Generally, it is satisfactory to anchor one end of the inner container firmly to prevent any direction of freedom, and support the other end with only two directions of restraint.

An interesting example of this type support is the conventional Dewar vessel. The neck tube is the main support while a steady-rest at the bottom provides for lateral support without vertical restraint. The thermal conductivity down the neck tube is largely offset by the cooling effect of the evaporated cryogenic fluid which is being vented. In some cases, this effect can be emphasized by a loose fitting stopper in the neck tube so all the gas flows in good thermal contact with the wall of the neck tube.

The problems of thermal expansion and contraction are also evident in the piping for larger cryogenic equipment. Bends in the piping keep the stresses at reasonable value, and also provide a longer heat flow path between the warm and cold ends. It is essential, however, that the piping path move gradually from the cold to the warm wall. A haphazard arrangement of the piping would make it act as a heat pump, moving heat inwards from a portion of the piping near the warm walls.

General Precautions

Combustibility of the materials used in cryogenic work can not be ignored, even if it is expected that only inert fluids will be used. This is particularly true where the material is porous or finely divided. Such material could absorb large quantities of air if the vacuum is lost. Since oxygen is higher boiling than nitrogen, there is a possibility that the oxygen concentration may increase above normal. An intimate mixture of oxygen and a combustible material would be extremely hazardous.

Cryogenic equipment presents no great hazard when handled properly, and consideration is given to unusual conditions. For example, a bursting disk on the vacuum casing is essential, even though the vessel is for operation at atmospheric pressure. One reason is that the adsorbent which is carried in the insulation space can store large quantities of gaseous products as long as the adsorbent is cold. If the vessel and adsorbent warm up, the gas would be released and sufficient pressure can be created to damage the inner container.

Likewise, the inner container must be kept clean. Since this is maintained at low temperature, there is a possibility of condensation of hydrocarbons, especially when the evaporation losses are not consistent enough to keep the piping and openings purged. These hydrocarbons, plus the tendency of liquid air to become constantly enriched in oxygen, can create conditions which might lead to danger.

All piping in cryogenic equipment should be pitched so as to avoid traps which would interfere with easy drying after cleaning. All cleaning fluids become solid at cryogenic temperatures. Cleaning fluids must be completely removed before the equipment is placed in service. Evaporation of solvent cleaning fluids can be assured only after very thorough purging with a warm, dry, clean gas or by evacuation to a very low pressure.

Care should be taken in the installation of valves so that a fluid cannot be trapped within the valve or between two valves. Such trapped fluids might create tremendous pressure when the equipment is warmed. In the common gate valve, for example, the fluid in the bonnet portion is completely trapped when the valve is seated. To avoid damage to the valve or packing, it is advisable to vent the bonnet volume to downstream side of the valve, usually by a drilled hole in the valve body or in the valve disk. A drilled hole in the valve body is preferred, however, to avoid the chance that the valve disk may be installed incorrectly.

Liquid trapped between two valves creates much the same condition. Where the volume of the piping is small, a bursting disk may be used to prevent damage. Where the volume is great, it is preferred to use a safety valve to obtain a less violent discharge of fluid.

Properties of Metals at Room and Liquid Nitrogen Temperatures—Table II

	Yield Strength, Psi.		Ultimate Strength, Psi.		Impact, Ft.-lb.		Thermal Conductivity, Btu., ft./hr., sq. ft., °F.	
	70 F.	−320 F.	70 F.	−320 F.	70 F.	−320 F.	70 F.	−320 F.
Copper	11,000	10,000	32,000	53,000	43 *I*	50 *I*	240	341
Everdur *	22,000	35,000	74,000	100,500	73 *C*	69 *C*	19	13
CDC 772 (Mn-Cu-Ni)	95,000	.....	115,000	.....	...	...	4.84	....
Mild carbon steel	50,000	139,000	80,000	140,000	30 *C*	2 *C*	35	31
Stainless steel (18-8)	49,000	68,000	85,000	212,000	80 *C*	75 *C*	8.7	4.9
Aluminum (5154)	34,000	40,000	44,000	59,000	97 *C*	50 *C*	67	37
Hastelloy	68,500	82,030	135,320	181,540	60 *I*	53 *I*	6.4	4.2
Monel	20,900	29,600	70,800	113,000	90 *I*	97 *I*	12	8.1

* All alloys annealed.
C = Charpy impact test; I = Izod impact test.

Materials Handling and Safety Requirements

Cryogenic fluids are generally handled out of contact with air because water, carbon dioxide, hydrocarbons, and even oxygen tend to condense into them. Since the fluids are normally at the boiling point, the piping should contain no syphon arrangements because there will be some evaporation at the top section or in the downcomer leg.

Evaporation in the piping is always accompanied by a tremendous increase of volume of that portion of the fluid. There will also be a considerable increase in fluid flow velocity. Accordingly, it is best to keep the fluid under sub-cooled conditions in the piping. This is usually accomplished by pressurizing with nonequilibrium gas pressure or by using mechanical pumps.

Nonequilibrium gas pressure may be from a material of lower boiling point, as for example, nitrogen or helium over oxygen. Or, it may be the same as the liquid, as for example, warm oxygen over liquid oxygen. Use of a lower boiling point gas has the advantage that there would be less gas needed, but the top layer of the liquid will be contaminated with some condensation or solution.

Gas phase of the fluid is most commonly used to create the nonequilibrium pressure needed for transfer. The gas can be obtained from a pressure receiver, or can be obtained by evaporating a part of the product fluid. The latter is accomplished by allowing liquid from the container to flow by gravity to an evaporator generally located under the apparatus. The evaporated gas is conducted to the top of the container.

Since the gas is under pressure greater than the saturation pressure for the liquid, there will be instant condensation of a small portion of the gas in the top layer of the liquid. This layer becomes warmed to saturation, and condensation ceases except for the heat transmitted through this layer to the colder liquid below. Where the fluid is static, and the pressure is maintained for relatively short periods, the total condensation is not considerable.

Condensation from the gas phase can be reduced by providing an insulation cover to the liquid. This can be in the form of a number of light nonconducting balls which float on the surface of the liquid, or it can be a single floating insulated cover which is free from the side walls of the vessel. In reducing evaporation during transfers better results can be obtained by using mechanical pumping of the fluid.

All cryogenic fluids can be handled by pumps much as water is pumped. Because of the low temperature, low heat of vaporization, and being at or close to the boiling point, special problems are introduced.

Development of self-lubricated materials has done much to simplify pump construction, but the problem of pumping a fluid at its boiling point is a serious one. Accordingly, systems usually incorporate a combination of gravity or pressure transfer or both as a first stage of a multistage pump effort. The better suited the pump, the less first-stage is needed to prevent boiling and loss-of-prime in the pump suction.

Use Mechanical Pumps

Centrifugal, regenerative turbine and positive displacement pumps are used. Each pump is best suited for some specific application. The centrifugal is best used where the volume to be handled is large and only a nominal pressure rise is needed. This type can be used in multistage units for higher pressures, upwards of ten stages being used in some commercial applications.

Centrifugal pumps for cryogenic fluids are built along the general design of a water pump. There seems to be no limit to their size and capacity. Although the efficiency of the centrifugal pump is high, this is achieved only when adequate pressure is supplied to keep the suction line completely full of liquid at all times.

Regenerative turbine pumps have the ability to develop relatively higher pressure per stage. At the same time, they operate with less net suction head than is required for a centrifugal pump. However, efficiency is only about 35%, so turbine pumps can not be immersed in the fluid, but must be connected to the tank by piping.

Positive displacement pumps are best suited for delivery of fluids to very high pressures—up to 10,000 psi. Many forms of positive displacement fluid pumps can be used and many are in commercial operation. In all cases, the problem of filling the pumping chamber is of major importance, and quite substantial nonequilibrium gas pressure is frequently used on the suction. In addition, the pumps are sometimes immersed to provide the absolute minimum of suction restrictions and to provide for dissipating the friction heat so it does not interfere with pump chamber filling.

The most popular arrangement of positive displacement pump for cryogenic use is one where a reciprocating plunger operates through a close-fitting sleeve in a conventional pump cylinder which is immersed in the fluid. The low pressure end of the sleeve is vented to the gas phase of the supply tank, to maintain or increase the positive pressure on the pump suction. The only positive leak-tight seal needed would be against the supply tank pressure. The labyrinth effect of the sleeve bushing on the plunger is nearly enough leak-tight for pressures to 10,000 psi.

Use Safe Handling Techniques

Handling of cryogenic fluids is not inherently dangerous. There are two features which can be considered as potential hazards: the very low temperature and the tendency of the fluids to boil and evaporate even in insulated containers. Care must be taken that the fluid is not spilled on the person because the sudden chilling causes a deeply frozen spot which reacts very much like a burn. It is essential that the fluids be kept in insulated containers and piping to guard against accidental freezing of bare hands to the metal. Also gloves and goggles should be worn to guard against burns from spatters.

Tendency of fluids to evaporate makes it essential to contain them in vented vessels, or in vessels with adequate relief devices. These relief devices must be such that they will not be made inoperative by frost, snow or moisture collection resulting from a previous operation. Where the device is of the intermittent type, it is best to provide for a sufficiently long interval be-

tween operating cycles to permit melt-off of frost and snow, and run-off of water before the device operates again.

Somewhat akin to the care in containing a cryogenic fluid in a closed vessel is the care that must be taken to see that the liquid can not be trapped in a section of pipe by the closure of two separate valves. Liquid so trapped will inevitably evaporate and create tremendous pressures.

What's Ahead

Research on the physical properties of matter at low temperatures has resulted in discoveries of paramount importance to the scientific world. Among them are: (1) confirmation of the third law of thermodynamics, (2) direct evidence of molecular rotation in solids, (3) the laws of Curie and Weiss for paramagnetic materials, (4) discovery of ortho and parahydrogen, (5) early confirmation of quantum theory in finding that below —350 F. the specific heat of hydrogen falls to that of a monatomic gas, (6) superfluidity and the quantum nature of liquid helium and (7) superconductivity.

Predictions of how these developments will eventually benefit industry would be pure guess work. It has only been within the last decade that any of these discoveries have interested industry sufficiently for them to spend research dollars in this field.

As little as twelve years ago a list of laboratories in this country that could do research at temperatures down to 2R. consisted of nine university laboratories and the National Bureau of Standards. Today, due in large part to the development of a commercial liquefier by S. C. Collins, it is estimated that perhaps 100 laboratories, both university and industrial, do some work at these extremely low temperatures.

This upsurge of industrial research is based in part on the fact that thermal noise in solid-state devices may be reduced to a minimum by operating at temperatures below —320 F. Other important developments are based on the superconducting properties of many metals and alloys at temperatures from —425 F. downward.

Development of Cryogenic Fluids

Until very recently the term cryogencis was applied only to the pure science of low temperature techniques. The engineering aspects were limited to construction of equipment which the scientist could use in further studies. These studies have shown that engineering applications are worth while, and that new cryogenic products are essential to an expanding economy. The temperature limits of cryogenics are by definition low, from —150°F all the way to absolute zero. The upper limit is quite arbitrary and will probably be lowered in the future.

Very low temperatures are not new. Liquid oxygen was first made in 1877 by Cailletet and Pictet, liquid hydrogen in 1898 by Dewar and helium was liquefied in 1908 by Kamerlingh-Onnes at Leiden. The oxygen industry has been the largest user of low temperature techniques because commercial production of oxygen has required the liquefaction of air and its subsequent distillation.

During the past 30 years, oxygen has been distributed widely in the liquid phase. Activity in this field has been accelerated during the past few years. Experience in the oxygen industry is being drawn upon to provide background for the production and handling of other cryogenic fluids which are necessary for industrial scale studies at lower temperatures.

Some of these low-temperature devices are low-temperature bolometers, the Versatron (Strandberg) and Maser (Townes and Bloembergen) for amplification of microwaves, and the Cryotron (Buck), Persistitron (Buckingham) and Persistor (Crittenden) and trapped flux (Crowe) superconducting devices for computer elements. It might be said that industrial research and development on devices of this kind has gone into high gear.

Still other applications of low temperatures are undergoing research in university and government laboratories and are yet of remote interest to industry. Liquid hydrogen, helium and xenon are being used in targets for high energy beams either as detectors or moderators. One such detector, used as a bubble chamber by Glaser at University of Michigan, required 10,000 gaseous liters of xenon. This volume is the largest single shipment of xenon ever made by the gas industry. The large hydrogen bubble chambers use 550 liters of liquid.

Research has been done on the use of liquid hydrogen in cooling the windings on electromagnets to increase their conductivity and the intensity of the resulting magnetic field. During and since World War II research and development work has been carried out on obtaining deuterium by rectification of liquid hydrogen.

The popular concept of the cessation of molecular motion at very low temperatures and the reduced level of ordinary thermal energy imply an absence of chemical activity in the low temperature region. Despite this rather discouraging picture considerable research effort is now being expended, principally by a group at the National Bureau of Standards in Washington, D. C., to explore the possibilities of a new field, cryogenic chemistry. Most of this research is concerned with systems which contain built-in energy sources in the form of atomic gases or molecular free radicals frozen into a matrix of solidified gas.

Pioneer in this new chemistry is Professor F. O. Rice of Catholic University. He has produced new transient modifications of sulphur and phosphorus. By vaporizing these elements and passing the vapor through either a high temperature furnace or an electric dis-

charge, he reduced their complex molecules to simple forms and then trapped these high temperature forms by freezing the vapors onto a liquid nitrogen cooled surface. With this technique he produced green and purple sulphur which he showed to be binary and quatenary molecules and brown phosphorous, a binary molecule.

Dr. Broida and Professor Pellam, now of Cal. Tech., succeeded in freezing on a liquid helium cooled surface at 7 R. the products from gas streams passing through high frequency electric discharges. Solids collected from nitrogen, oxygen and hydrogen, glowed during deposition and fluoresced for some time after the discharge was stopped. Furthermore, these solids emitted light during subsequent warm-up which showed that some energy had been tropped at the low temperature.

A frequently mentioned potential application for these low temperature stored energy systems is as super propellants for rockets. The NBS group and others are now trying to unravel the mysteries of these fascinating observations, and at the same time lay the foundations of a new chemistry.

Another direction of research involving the moderately low temperature region is in the field of polymerization. Several groups, notably one at Brooklyn Polytechnic, have succeeded in polymerizing some frozen hydrocarbons by using γ-radiation as the energy source.

Future work may allow tailored polymers to be obtained through polymerization of solids already possessing a high degree of order. Systems normally incompatible may be frozen into ordered crystalline structures and subsequently polymerized through the use of a free radical or atomic gas trapped in the solid mass.

Thus far, we have reviewed very briefly some of the future developments that will require low temperatures. To make these economical and practical will be a problem for the low-temperature physicists and cryogenic engineers.

Since 1947, when Collins developed his efficient helium liquefiers, liquid hydrogen and helium have been available to any laboratory at a definite cost. This has promoted research and development work at low temperatures. Recently the Linde Company has begun the commercial distribution of liquid hydrogen in 100-liter lots to enable other laboratories to use this low-boiling liquid with greater convenience. However, other cryogenic developments will be needed to insure continued growth.

Perhaps the first requirement to be considered is the problem of raw material supply. An economic analysis of the cost of producting liquid hydrogen shows that ultimately the major cost factor will be that of producing pure gaseous hydrogen. Costs appears to be decreasing with the increased use by the chemical and metallurgical industries.

The gas industry is diligently working at the problem of utilizing coke oven gas or partial oxidation of petroleum fuels as a source for large quantities of pure hydrogen. This is a technical problem to be solved by ingenuity and know-how, but the helium supply situation is of an entirely different character.

The only economical source of helium is from the natural gas of certain areas in the southwest United States. Since the first World War, the production and supply of helium gas has been controlled by the United States Department of Interior through the Bureau of Mines. For many years, this wartime developed supply was sufficient.

Following World War II, however, demand has exceeded production in spite of the expansion programs of the Bureau of Mines. Although the situation might be relieved in large measure for several years to come by industrial participation in the production of helium, the ultimate supply of helium will almost certainly remain limited. Use of this gas in cooling low-temperature devices will require that helium be recovered for re-use. Perhaps the best way to answer this problem of raw material supply for hydrogen, neon, or helium will lie in the development of closed cycle refrigeration systems using these gases as working fluids.

A major development that would do much to aid in the use of low temperatures would be a closed-cycle refrigerator with the same reliability and ease of maintenance as the household refrigerator. Engineering design on such refrigerators has been a matter of conjecture and research for several years. Recently the Phillips Research Laboratories in Eindhoven, Netherlands, introduced the Norelco refrigerator, which uses helium as the working fluid to achieve temperature down to −320 F. Perkin-Elmer has also introduced a very small nitrogen refrigerator for cooling infrared detectors. Continued developments along this line are certain to come.

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His work since then has been principally in the handling and processing of cryogenic fluids. Linde now holds 25 *patents in his name.*

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He is also a licensed Professional Engineer in New York and a member of NSPE.

Mr. Hansen acknowledges the assistance of Dr. J. C. Brantley, Dr. L. C. Matsch, F. A. Wilson and all members of Linde's Tonawanda laboratory in the preparation of this report.

Reprints Available

For an additional copy of this 16-page feature report on low temperatures, circle Reprint No. 133 on Reader Service Card (p. 205). Price 50¢/copy.

If you make calculations for nitrogen compounds, you can save time with these six charts.

Design Data for Oxides of Nitrogen

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Food Machinery & Chemical Corp., Princeton, N. J.

NITROGEN compounds are assuming greater importance in the chemical industry. And, in almost every case the oxides of nitrogen—NO, NO_2, N_2O_4—are the bases of the operations. Some of the fields that hold promise of expanding uses of nitrogen compounds are: fuming nitric acid in rocketry, nitration of organic materials (nitro-paraffins, e.g.) and, of course, industries such as fertilizers and explosives.

Possibly the latest appearance of nitrogen compounds on the non-chemical scene is in polluted air or smog. Here, nitrogen oxides are suspected of contributing to this problem.

Therefore, engineers and others are becoming more aware of the oxides of nitrogen, their reactions, the equilibrium conditions they attain, and their chemical and physical properties. The data presented here simplify many of the engineering calculations concerned with these materials.

Calculations for oxides of nitrogen or nitric acid involve equilibrium relationships which can become complicated. The calculations are often tedious and time-consuming for the engineer.

We have, therefore, put most of these equilibrium data into graphical and nomographical form. With the material in this article, an engineer can save much time and effort—e.g., when making calculations for the recovery or handling of oxides of nitrogen.

To illustrate the use of the charts, we have chosen an example problem in the design of an absorption tower for HNO_3 production. Wenner[2] has described this process and its equilibrium calculations in detail. We recommend that his method be studied and compared with the simplified one illustrated here.

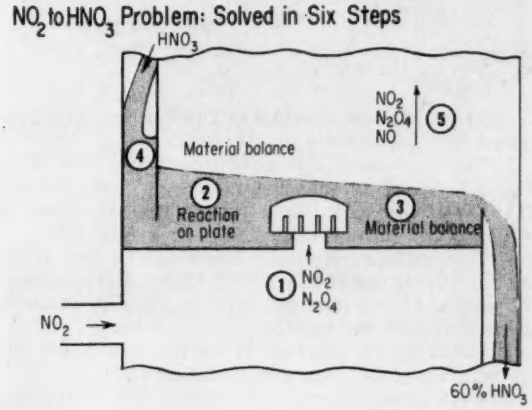
The sketch at the left above shows the streams involved in the calculations around a plate in the absorption tower. The numbers refer to steps in the calculation procedure below.

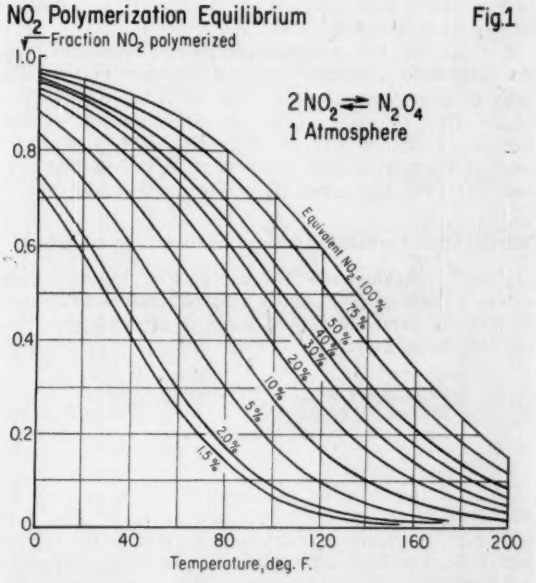
Wenner assumes the following reactions occur in the acid absorption tower:

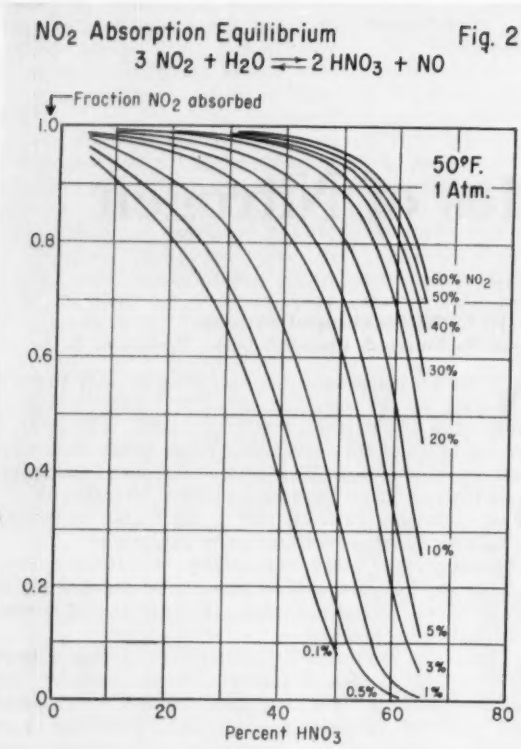
$$2\ NO_2 \rightleftarrows N_2O_4 \quad (1)$$
$$3\ NO_2 + H_2O \rightleftarrows 2\ HNO_3 + NO \quad (2)$$
$$2\ NO + O_2 \rightarrow 2\ NO_2 \quad (3)$$
$$HNO_3 + H_2O \rightarrow HNO_3(aq) \quad (4)$$

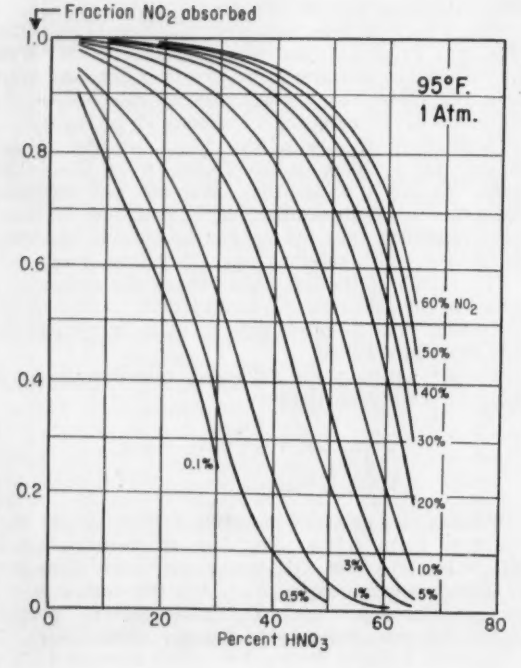
Wenner also assumes that N_2O_4 does not react with water to form HNO_3. The N_2O_4 must dissociate to NO_2 before reaction with water can occur. This may be a controversial assumption, but the design is corroborated by actual operation; other factors—such as plate efficiency—compensate for any error.

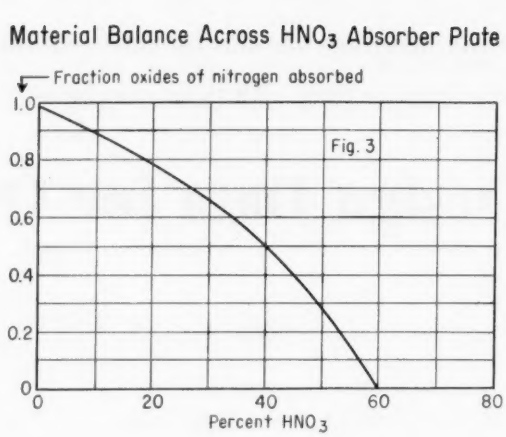
The acid tower is designed by going through a plate-











to-plate calculation starting at the bottom. The suggested method consists of six steps:

1. Calculate equilibrium between NO_2 and N_2O_4. Fig. 1 is based on equilibrium-constant data for Eq. (1). Note that the NO_2 compositions are given in terms of percent equivalent NO_2—including N_2O_4.

2. Determine equilibrium between NO_2 and HNO_3 for Eq. (2) by use of Fig. 2. Find partial pressures of the oxides of nitrogen leaving the plate by material balance around the plate.

3. Calculate the fraction of oxides of nitrogen absorbed on a plate from a material balance.

4. Determine the concentration of HNO_3 entering the plate from the one above from Fig. 3, covering a nitric acid and water material balance.

5. Find the amount of NO converted to NO_2 between plates before starting the next plate calculation. In Fig. 4 are nomographs which simplify calculations for the reaction in Eq. (3).

6. Calculate the cooling-surface requirements from the total heat generated on and between plates. The heat of polymerization of NO_2 to N_2O_4, Eq. (1), is 23,400 Btu./lb. mole N_2O_4, and of oxidation of NO, Eq. (3), is 25,500 Btu./lb. mole NO. Ref. 5 gives the heat of formation and dilution of HNO_3 in Eqs. (2) and (4). All three reactions are exothermic.

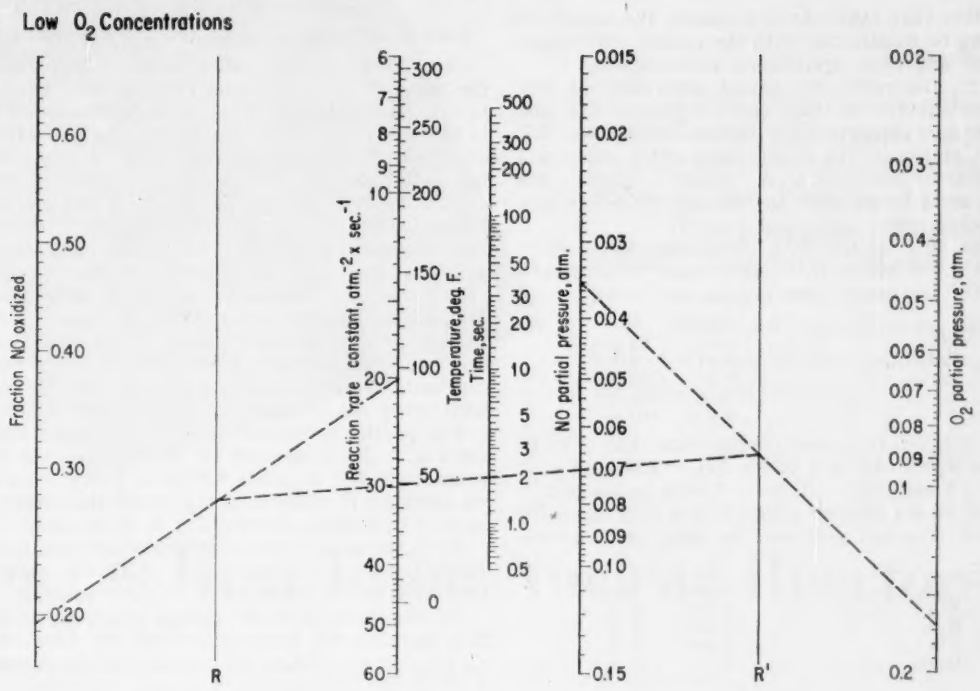
Nitric Acid Column Design Shows Use of Charts

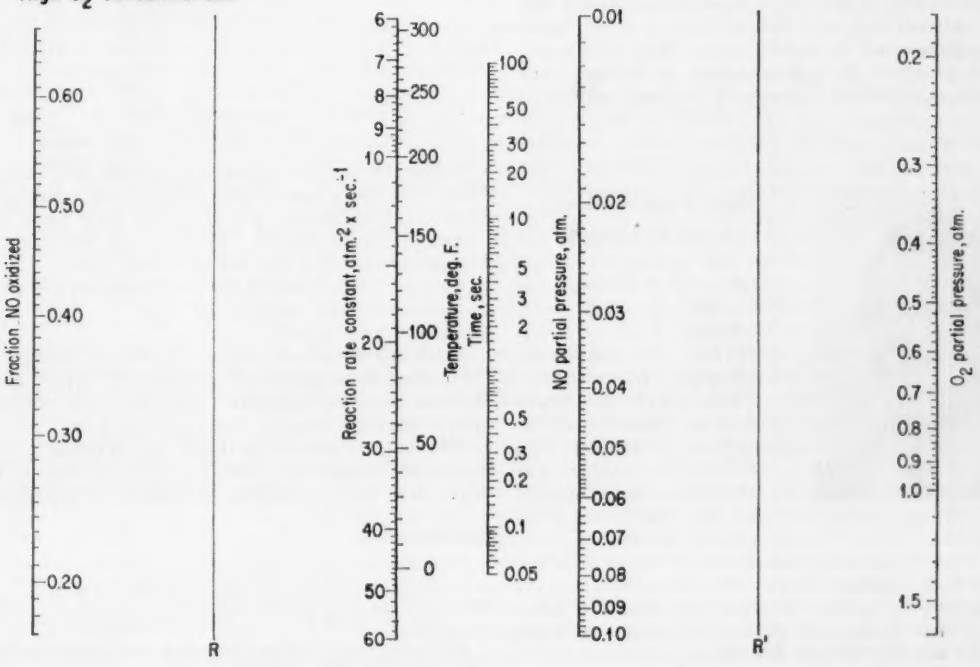
Step 1: To illustrate the use of Fig. 1, assume gas enters a plate at 95 F. and 1 atm. equivalent to 30 mole % NO_2. If the basis is 1 lb. mole of entering gas, then its composition is:

	Moles	%
Equivalent NO_2.....	0.30	30.0
Inerts (O_2 & N_2).....	0.70	70.0
	1.00	100.0

Correct the entering gas composition to account for the equilibrium between NO_2 and N_2O_4. In Fig. 1 all NO_2-N_2O_4 components must be converted to the equivalent NO_2. For 30% equivalent NO_2 at 95 F., the graph indicates that 50% of the total NO_2 is polymerized to N_2O_4. Therefore, the true gas analysis is:

NO Oxidation Rate for: $2\,NO + O_2 \longrightarrow 2\,NO_2$ Fig. 4





	Moles	%
NO_2	0.15	16.2
N_2O_4	0.075	8.1
Inerts	0.70	75.7
	0.925	100.0

For other than atmospheric pressure, the same type graph can be constructed with the proper equilibrium constants[5] and from equilibrium relationships.[3]

Step 2: Determine the actual absorption of NO_2 from the equilibrium that exists between NO_2 and HNO_3. In this absorption the equilibrium between NO_2 and N_2O_4 shifts as NO_2 is absorbed, which requires a trial-and-error calculation. A "pseudo" entering gas analysis must be assumed and the exit NO_2-N_2O_4 content checked.

Assume 40% of the N_2O_4 dissociates; or, $0.40 \times 0.075 = 0.030$ moles N_2O_4 dissociates forming 0.06 moles NO_2. The pseudo entering gas is:

	Moles	%
NO_2	0.21	22.0
N_2O_4	0.045	4.7
Inerts	0.70	73.3
	0.955	100.0

If 60% HNO_3 is formed on the plate, Fig. 2 at 95 F. shows that about 44% of the NO_2 is absorbed as in Eq. (2). Thus, $0.21 \times 0.44 = 0.0924$ moles NO_2 is absorbed. In the reaction $0.0924/3 = 0.0308$ moles NO is formed. The exit gas from the plate has this composition:

	Moles	%
NO_2	0.118	13.1
N_2O_4	0.045	5.0
NO	0.031	3.5
Inerts	0.70	78.4
	0.894	100.0

Check NO_2-N_2O_4 equilibrium: equivalent $NO_2 = (0.118 + 2 \times 0.045)/0.894 = 23\%$. For this concentration, from Fig. 1 the total amount of equivalent NO_2 is 44% polymerized, or $0.208 \times 0.44 = 0.091$ moles NO_2 is polymerized to 0.0455 moles N_2O_4. This confirms the assumed N_2O_4 dissociation in the exit gas.

Step 3: A material balance of the total oxides of nitrogen (NO, NO_2, N_2O_4) is obtained from the calculations of Step 2:

Entering: 0.300 moles equivalent NO_2
Leaving: 0.239 moles equivalent NO_2

Absorbed: 0.061 moles equivalent NO_2

Fraction oxides of nitrogen absorbed = $0.061/0.30 = 0.203$

Step 4: Find the concentration of HNO_3 leaving the plate above from Fig. 3. The basis of this graph is that standard 60% HNO_3 is the product, and water is the absorbent liquid. From Fig. 3, for a fraction absorbed of 0.203, the concentration of acid entering the plate from the one above is about 53%.

Step 5: Calculate the oxidation of NO to NO_2 between plates. For all practical purposes, the partial pressure of O_2 is assumed to be constant, and the nomographs in Fig. 4 are based upon this assumption. The velocity or rate constants are those determined by Bodenstein.[1] Higher values have been obtained by later workers,[2, 4] but the conservative values of Bodenstein are indicated on the nomographs. If other reaction constants are preferred, the nomographs can still be used, since the constants themselves are shown.

The partial pressures of NO and O_2 are required for Fig. 4. From the exit gas composition, the partial pressure of NO is $(0.031/0.894) \times 1 = 0.035$ atm. If we assume 0.15 moles O_2 in the inerts, the partial pressure of O_2 is $(0.15/0.894) \times 1 = 0.168$ atm.

Since the usual "residence" times between plates in HNO_3 towers are on the order of 1-2 sec., assume a time of 2 sec. between plates for our example.

On Fig. 4, connect the partial pressures of O_2 and NO, marking the intersection with R′. Connect time (2 sec.) with point on R′, intersecting R. Connect 95 F. with the intersection of R, and read fraction NO oxidized = 0.194. Thus, $0.031 \times 0.194 = 0.006$ moles NO_2 is formed, and $0.006/2 = 0.003$ moles O_2 used. Composition of gas entering the next plate above is:

	Moles	%
NO_2	0.124	13.9
N_2O_4	0.045	5.1
NO	0.025	2.8
O_2	0.147	16.5
N_2	0.550	61.7
	0.891	100.0

Since the balance between NO_2 and N_2O_4 has again been disturbed, and a new equilibrium condition has been created, the exit gas from the plate must be corrected utilizing Fig. 1. The method has been illustrated earlier, and will not be shown again.

Step 6: Calculation of the heat generated is required to determine the cooling coil area for dissipation of the heat on each tray.

With the data here, an acid tower containing 18 to 36 plates can be calculated in about 4 to 8 hrs., once the method becomes familiar. The textbook method requires perhaps four to five times as long.

The author wishes to thank the Wisconsin Alumni Research Foundation and Food Machinery & Chemical Corp. for permission to publish this article.

Meet Your Author

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Gene is now with the Chemicals Division of Food Machinery & Chemical Corp. He has served on the staffs of several vice-presidents of the company doing plant technical liaison and process economic evaluation work. He is a member of AIChE.

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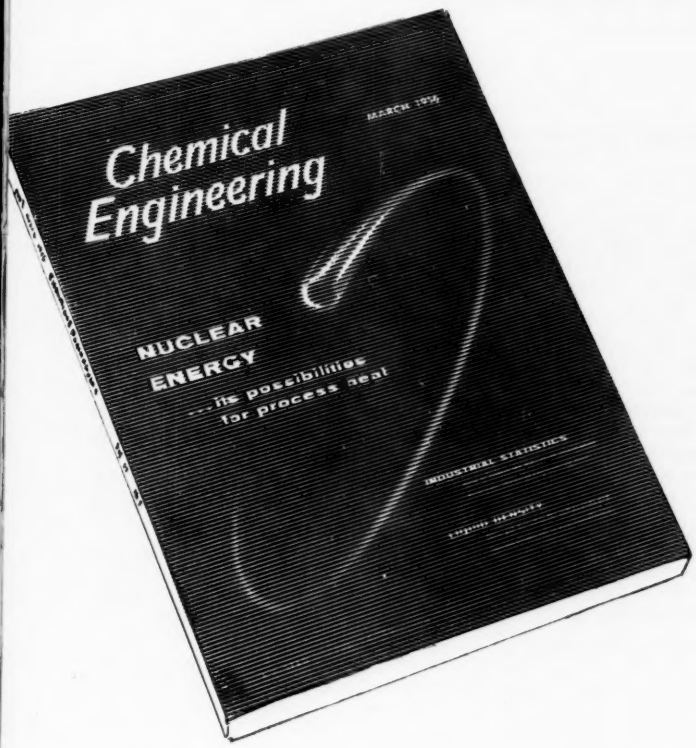


Three years ago we published a prediction that nuclear energy might compete for the job of process heating, possibly by the year 1959.

What's happened? What has been actually accomplished and what technical problems still remain unsolved?

Here's an up-to-date report on a subject of great importance to the chemical process industries.

Process Heat From Nuclear Reactors

HARRY PERRY and JAMES P. McGEE, Bureau of Mines, U. S. Dept. of the Interior

IN THE U. S., major emphasis on use of nuclear energy—other than that related to special military applications—has been on the generation of electrical power. However, even the most optimistic forecasters believe that power from fission, or eventually from fusion, will not compete with power from conventional fuels for a number of years in this country.

Except for military applications where cost is secondary, the most favorable economic conditions for applying nuclear energy lie in those fields where relatively high-cost energy is being used, such as in the gasification of coal. Also, the Bureau of Mines believes that nuclear energy for chemical and metallurgical operations might offer some other process advantages.

Among the possibilities are the unlimited temperatures theoretically available with nuclear heating and the potential availability of the energy at elevated pressures at little or no additional cost.

In our work at the Bureau of Mines we have considered the comparative economics of using nuclear energy instead of conventional fuels for supplying process heat in these operations: reforming methane to hydrogen; coal gasification; low-temperature carbonization of coal; ferrous and nonferrous metallurgy; petroleum refining; production of acetylene; and direct fixation of nitrogen. Here are some of our conclusions.

HARRY PERRY *is Chief, Branch of Bituminous Coal Research in Washington, D. C.;* and JAMES P. MCGEE *is special assistant to the Chief, Branch of Coal Gasification, Region V, in Morgantown, W. Va.*

From Methane to Hydrogen

Today, 80% of the ammonia produced in the U. S. comes from methane as the raw material. Methane is reformed to the hydrogen required to produce NH_3.

Hydrogen is also a raw material for many other chemical processes and many new important uses can be developed when cheap hydrogen becomes available, e.g., coal hydrogenation to produce liquid fuels; and the direct reduction of iron ore.

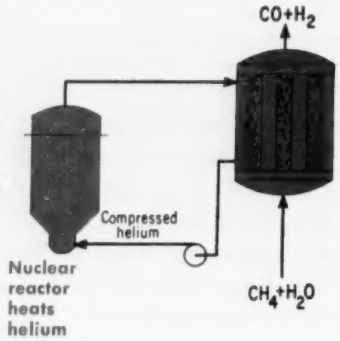
Two processes to reform methane are now in use. In tube reforming, methane and steam react over a nickel catalyst at 1,500 F., at approximately 1 atm. The catalyst is suspended in alloy steel tubes externally heated by combustion of methane and air. The process is inefficient thermally; approximately 700 Btu. are required/cu. ft. of methane reformed. Theoretical heat requirement is only 220 Btu./cu. ft. of methane (approximately 250 Btu. allowing for radiation losses).

An alternate process depends upon partial combustion of methane in oxygen of 95%, or higher, purity. This process has the advantage of generating the hydrogen at 30 atm., the most economic pressure for many uses. Stoichiometric ratio of oxygen to methane is 0.5. Theoretical yield, after the water-gas shift, is 3 volumes of H_2/volume of CH_4.

We've sketched a hypothetical process for reforming methane (or other low-molecular-weight hydrocarbon gases) with steam using nuclear heat. See next page.

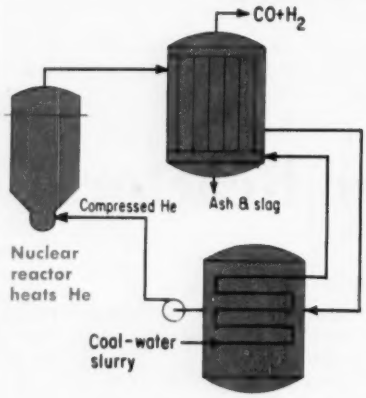
Comparing the proposed nuclear process with tube reforming, the unique quality of nuclear heating using a recycle gas as the heat car-

Here's How Nuclear Heat Might Reform Methane



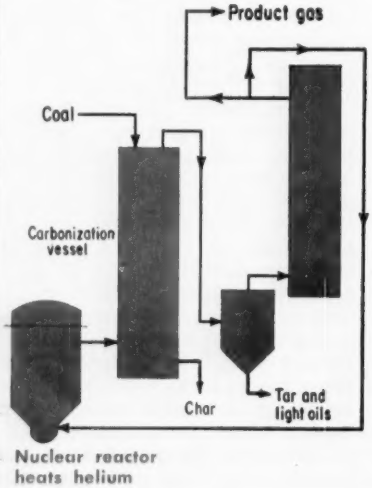
Reforming methane (or other low-molecular weight hydrocarbons) using nuclear heat might be done this way. Methane and steam pass through a heat exchanger, the tubes of which are filled with a Ni catalyst. Reaction proceeds at 1,700 F. and 30 atm., and is endothermic. Circulating helium, heated to 2,000 F. at 30 atm. in a nuclear reactor, supplies process heat and recycles at 500 F.

Nuclear Scheme Bids for Coal Gasification Job



Coal and water in the ratio of 1.5 lb. of water/lb. of dry ash-free coal mix in a slurry tank. Then the slurry is pumped through preheater tubes where the coal-steam mixture is heated to 600 F. The mixture next enters the gasifier where the temperature is raised to between 1,700 and 2,500 F.; and heat is supplied for the endothermic steam-carbon reaction. Heating medium for both the preheater and gasifier is helium recycling through a nuclear reactor. Pressure of the helium and of the reactants is balanced at 30 atm. to eliminate stress in the tubes.

Low-Temperature Carbonization Could Be Done This Way



A fluidized system is visualized with the heat of carbonization added by preheating a portion of the evolved gas by recycling through a nuclear reactor and then through the carbonizer. The heating value of the gas produced is a function of the carbonization temperature for different ranks of U. S. coals. If production of gas alone were the only consideration, carbonization temperature of 600 C. (1,112 F.) would be chosen for many coals since it favors the formation of large quantities of a high-Btu. carbonization gas which could be used as a substitute for natural gas. In selecting the actual temperature of carbonization in any process, an economic balance would be made first.

rier, is the elimination of stack loss. The unused portion of the heat in the carrier gas returns to the reactor. Only heat loss is through radiation.

Therefore, nuclear heat could be about 3 times as efficient as tube reforming (250 Btu. vs. 700 Btu.). If methane costs 35¢/1,000 std. cu. ft., or 35¢/million Btu., then nuclear heat could compete at a price of about $1/million Btu.

Also, the conventional tube process cannot generate hydrogen under pressure since at the high temperatures required a balanced pressure must be maintained across the tubes to eliminate stress. Compression costs for methane and air used to supply heat for reforming make this uneconomic. Moreover, in the nuclear process the hydrogen would be generated at 30 atm. and an additional 8¢/1,000 std. cu. ft. in compression cost can be realized if the hydrogen is used at 30 atm. or more.

Comparing the nuclear process with partial oxidation, 25% of the methane/unit volume of hydrogen produced is saved and the cost of oxygen is eliminated. For 1,000 std. cu. ft. of methane processed, theoretical oxygen requirements are approximately 500 std. cu. ft. At a cost of $5/ton of 95% O_2, the oxygen has a value of 10.6¢. Cost of compression to 30 atm. adds another 4¢.

Potential savings in using nuclear energy are $1.23/4,000 std. cu. ft. of methane processed. This would produce 16,000 std. cu. ft. of hydrogen and would require 1,000,000 Btu.

Therefore, nuclear energy can compete for the job of reforming methane to hydrogen when it can be supplied at a price of $1.23/million Btu.

To Gasify Coal

For many years, almost all hydrogen and synthesis gas has been made by the cyclic water-gas process. Because of the high cost of coke in the U. S., alternate methods have been studied. Most highly developed method is partial combustion of coal with oxygen at elevated pressure.

In this process, steam, oxygen and coal react at 30 atm. Quantities of reactants required to produce 1,000 std. cu. ft. of a CO-H_2 mixture are about 35 lb. of bitu-

minous coal, 300 std. cu. ft. of 95% O_2 and 12 lb. of steam.

In contrast to the partial oxidation process, the nuclear system has the advantage of eliminating compressed process oxygen and reducing coal requirements by 40%. This system might require only 22 lb. of coal/1,000 std. cu. ft. of synthesis gas. For coal at $4/ton, the reduction of 13 lb. of coal results in a saving of 2.6¢/1,000 std. cu. ft. of $CO\text{-}H_2$ mixture. For oxygen at $5/ton, the elimination of 300 std. cu. ft. saves 6.3¢, and the elimination of oxygen compression saves at least another 2.4¢.

The proposed nuclear process (see sketch) requires a heat input of 160,000 Btu./1,000 std. cu. ft. of $CO\text{-}H_2$ mixture. In this application, then, nuclear heat would have to be available at 71¢/million Btu. to be competitive.

Low-Temp. Carbonization

Several processes have been proposed for the low-temperature carbonization of coal, but to be economic in the U. S. these processes must supply a liquid product that can be sold at prices that will pay for the processing of the coal and a market must be available for the char.

At the present time some of the evolved gas is burned internally to furnish heat for the process, and this yields a low-Btu. gas which has no other market in the U. S. Use of nuclear heat for carbonization would permit the production of a high-Btu. gas. Such a gas could have market value in countries where natural gas is not available, or even, eventually, in the U. S.

Approximately 500 Btu./lb., or 1,000,000 Btu./ton, of heat input is required for the carbonizing of bituminous coal at 600 C. Direct heating by burning a portion of the carbonization gas or by controlled admission of air to the carbonizer is used, although this results in dilution of the process gas with products of combustion.

Using nuclear energy to heat the recycle gas would give an 800-Btu./cu.-ft. gas, since there would be no dilution. At present, in direct heating, the gas has no commercial value except in the process itself. If the 800-Btu. gas could be sold for 30¢/1,000 std. cu. ft., nuclear heat would yield a product worth $1.20/ton of coal carbonized, with a consumption of only 1,000,000 Btu.

If low-temperature carbonization processes were used to treat coals that are to be burned in utility boilers, the char could be used for boiler fuel, the gases used for carbonization and the liquid products would be offered for sale. In the proposed nuclear process, the gas also could be offered for sale.

As much as 4,000 cu. ft. of gas/ton of coal might be produced. Approximately 70% of the heating value of the coal appears in the low-temperature char. Based on about 155,000,000 tons of coal burned in 1956 by U. S. utilities, a maximum potential 884,000-million cu. ft. of gas (approximately 10% of U. S. demand for natural gas in 1955) could be produced.[3]

Of course we don't expect that all utility plants would use low-temperature carbonization so that the total actually produced would be much smaller. Moreover, if a nuclear reactor were already available at a utility plant, the relative cost of producing electric energy from char and from nuclear energy would have to be examined carefully.

Other Possible Applications

A large percentage of heat used by the metallurgical industry is consumed in the standard blast furnace. The high cost of coke (about $20/ton) in the U. S. has prompted many studies of methods to reduce coke consumption, and of methods that do not require coke for reducing iron ores.

The coke consumed in a blast furnace heats the limestone and ore, reduces the ore, maintains the iron and slag in molten condition and supplies heat to make up radiation losses and that lost in the blast gases. If coke worth $20/ton is replaced in part with nuclear heat, on a straight replacement basis nuclear heat is competitive at 75¢/million Btu.

Melting of nonferrous alloys is largely accomplished by use of electric energy. On a direct replacement basis with electricity at 8 mills/kwh., nuclear heat has a value of $2.34/million Btu.

Most of the heat requirements of oil refineries are for cracking and distillation at relatively low temperatures in the range of 600-1,000 F. These requirements could be met with nuclear reactors being designed today. However, because of large amounts of residual fuel oil, which can supply all the heating requirements in the refinery, there would be no advantage at present in using another source of heat.

Acetylene is produced in the Wulff process by cracking natural gas in pebble beds or regenerators at about 2,600 F. The process is cyclic. First the pebble beds are heated by combustion of natural gas and then methane is cracked over the hot refractory surface with immediate quenching of the products. Two-thirds of the methane consumed in the process is used to heat the pebble beds.

Use of nuclear heating may offer the advantage of a continuous process with higher efficiency. Since stack losses are eliminated in the continuous process, thermal efficiency can be increased 50%. In this case, nuclear heat has a value of 52¢/million Btu. based on a methane cost of 35¢/1,000 std. cu. ft.

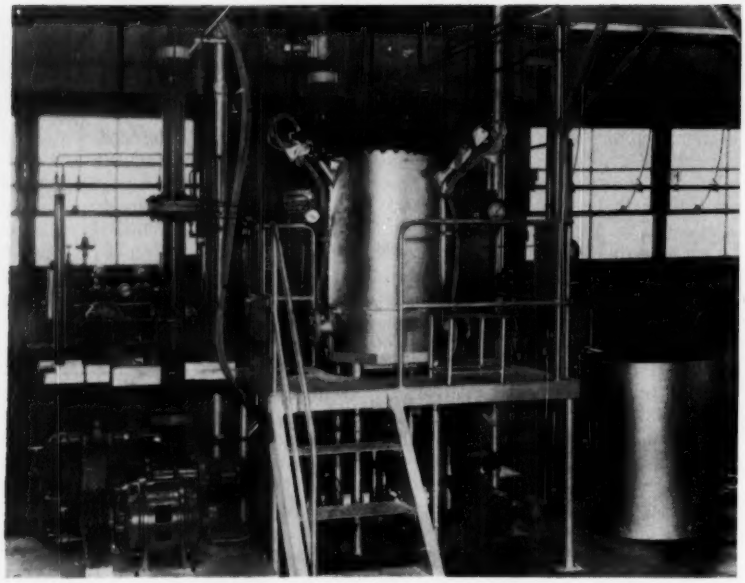
Where We Stand Today

Where do we stand in the development of high-temperature nuclear reactors that might be used for process heating?

Reactors using liquid sodium as a coolant are operating at temperatures of approximately 900 F. These are the highest temperatures reported at present. However, several design studies are under way for nuclear, closed-cycle, gas-turbine plants operating in the range of 1,250-1,450 F. The fluids which would seem most satisfactory for these plants are helium and CO_2. The fuel elements must have high retention of fission products and probably will be clad with stainless steel.

The Atomic Energy Commission and the Bureau of Mines have cooperated for several years on a feasibility study for an indirect process cycle reactor. The program has several parts:

1. To obtain heat-transfer data and to develop prototype components for the heat-transfer system, equipment is being operated using heat supplied by electric induction to simulate the heat of nuclear fission. Currently, our simulated system (see photo, next page) is operating at atmospheric pressure. Plans are under way for modifying this system to operate at 250 psi. The temperature range of 1,000-



HELIUM LOOP, heated by induction, simulates nuclear process.

2,500 F. across the simulated reactor will be identical to the atmospheric-pressure system.

As part of this study, the Nuclear Development Corp. of America was commissioned by AEC to prepare a conceptual design for a high-temperature test reactor. This study has been completed, and it was concluded that such a system is feasible and could be constructed and operated with a good chance of success.

2. When development of the system components such as recycle compressors, high-temperature heat exchangers, valves, etc., has been accomplished for the induction-heated loop, these components will be installed in an operating reactor. Nuclear fuel elements would be used in the in-pile loop, since the primary objective of such a system would be fuel-element testing.

3. After successful operation of an in-pile loop at the required temperatures and pressures, a high-temperature reactor would be designed and constructed. This type of reactor, as now visualized, would consist and would be designed to be subcritical at all element loadings. To allow the reactor to be critical, the center section would be surrounded by an outer zone which would, in effect, be a water-cooled reactor capable of achieving criticality and acting as a neutron source for the high-temperature sections.

Such a test reactor was proposed by Nuclear Development Corp. as a result of the feasibility study it conducted for AEC.

4. Upon solution of the major problems of fuel-element construction, reactor control, structural stability and system components, the final part of the program would consist of the design and construction of a high-temperature process heat reactor.

Problems Still Unsolved

Before a gas-cooled nuclear reactor operating at 2,500 F. can be successful (Part 4 of the program outlined above), considerable improvement will be needed of both the reactor proper and the external system components. Our research program will concentrate on these still unsolved problems:

Fuel-Element Design and Construction—Nuclear fuel elements capable of successful operation at temperatures of 2,500 F. and above would be far in advance of those in today's reactor designs. Both clad and unclad elements should be studied. For the indirect process cycle using helium, it may be possible to use unclad graphite elements fueled with uranium carbide. For the direct cycle or process stream preheating types of reactors, it will be necessary to have clad elements which can retain essentially all the fission products.

Reactor Pressure Vessel — For commercial-size process heat reactors, vessels will be needed 10 to 15 ft. in diameter, operating with internal pressures of 30 atm., or above. Suitable refractory linings must be developed to protect the steel shell.

Reactor Control — Control schemes which have been considered for high-temperature process heat reactors in the primary coolant system include poison rods, reflector control and regulation by controlling the amount of gaseous "poisons" such as xenon. None of these control systems has been used at these high temperatures and special problems are anticipated.

High-Temperature Circulating Compressors — For the indirect process cycle, compressors must be developed for recycling gases at temperatures of 1,000 F. and above. In addition to problems inherent in operating at high temperature, gases of low-molecular weight such as helium will require high compressor speeds or many stages.

Moreover, the recycled gas must not become contaminated by lube oil or oil used for sealing the compressor shaft. Due to the possibility of radioactive particles in the circulating primary coolant, leakage must be kept to an absolute minimum. This requires the development of a "zero leakage" shaft seal, or entails the "canning" of the compressor and drive.

High-Temperature Heat Exchanger—In a process heat reactor system using a gaseous heat-transfer medium, a high-temperature heat exchanger is required to operate at temperatures of 2,500 F. with reactants such as steam, air, hydrogen, etc. This will require ceramics or cermets fabricated into leakproof exchangers. Although this has not been accomplished yet, recent advances give hope of some ultimate solution.

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2. Graham, R. H., *Chem. Eng.*, March 1956, pp. 191-193.
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This article is a condensed version of a paper released at the 2nd International Conference on the Peaceful Uses of Atomic Energy, Geneva, Switzerland, Sept. 1958.

To find parachor, boiling points, specific gravity or critical temperature . . . use these

EQUATIONS

1. $\log [P] = -3.31 + 2.08599 \log (T_{10}/Sp.\ G.^{0.5878})$
2. $\log [P] = -4.20895 + 2.29319 \log (T_1/Sp.\ G.^{0.5937})$
3. $\log [P] = -8.93275 + 3.68894 \log (T_c/Sp.\ G.^{0.6676})$
4. $\log T_1 = 2.451 + 0.05901 \log Sp.\ G. + 0.90965 \log T_{10}$
5. $\log Sp.\ G. = -6.59654 + 16.946 \log T_1 - 15.415 \log T_{10}$
6. $\log T_c = 19.078 + 0.2985 \log Sp.\ G. + 0.62164 \log T_1$
7. $\log T_c = -0.68893 + 5.68002 \log T_1 - 4.60138 \log T_{10}$

Estimate Petrochemical Properties

R. NOKAY, Instructor, Chemistry Dept., Santa Ana College, Fullerton, Calif.

Parachor, critical temperature, boiling point and specific gravity are important properties of hydrocarbons and their inter-relationship has been extensively studied.

However, there are many places where limited data are available. In these ranges of few or no data, how can you estimate these properties?

In the absence of specific values, here are several empirical equations that will help you estimate these properties in pure hydrocarbons. These equations are limited to pure hydrocarbons with a normal boiling point between 400 and 1,400 R. and specific gravity between 0.5 and 1.0.

Nomenclature

$[P]$	Parachor
T_1	Boiling point at 1 atm. pressure, deg. Rankine
T_{10}	Boiling point at 10 mm. Hg pressure, deg. Rankine
T_c	Critical temperature, deg. Rankine
$Sp.\ G.$	Specific gravity
a, b, d	Constants

How Were the Equations Obtained?

Parachor $[P]$ is expressed as a function of temperature and specific gravity by the following equation:

$$[P] = a\left(\frac{T}{Sp.\ G.}\right)^b$$

Plotting $[P]$ against $(T/Sp.\ G.)$ on log-log paper for families of hydrocarbons gives different straight lines. To generalize these straight lines and bring them together into one straight line, the specific gravity must be raised to an exponential power d.

Following steps were used to determine the value for this exponent d:

• Parachor $[P]$ was plotted against $(T/Sp.\ G.)$ for various families of hydrocarbons.

High Accuracy of the Equations Makes Estimates Reliable

	Maximum Deviation, Percent											
	Eq. 1		Eq. 2		Eq. 3		Eq. 4 and 5		Eq. 6		Eq. 7	
	+	−	+	−	+	−	+	−	+	−	+	−
Normal paraffins, C_4 to C_{20}	1.02	0.95	0.90	1.40	1.22	1.42	0.20	0.14	0.24	0.15	0.70	1.20
Other paraffins	0.00	11.18	0.00	10.66	0.00	9.78	0.72	1.33				
Olefins	1.57	5.68	0.02	7.01	1.20	5.85	0.41	0.25	1.71	1.66	0.66	5.40
Naphthalenes	0.00	9.84	4.60	9.65	1.80	4.14	0.86	0.84				
Aromatics	6.68	4.85	4.39	8.56	5.00	6.41	0.72	0.75				

• We selected two values of $(T/Sp.\ G.)$ at the same $[P]$; one for a paraffin, one for an olefin.

• Since: $[P]_{paraffin} = [P]_{olefin}$

and:

$$[P] = a\left[\frac{T}{(Sp.\ G.)^d}\right]^b$$

therefore:

$$a\left[\frac{T}{(Sp.\ G.)^d}\right]^b_{paraffin} = a\left[\frac{T}{(Sp.\ G.)^d}\right]^b_{olefin}$$

When these straight lines are brought together, a and b become equal, so that:

$$\left[\frac{T}{(Sp.\ G.)^d}\right]_{paraffin} = \left[\frac{T}{(Sp.\ G.)^d}\right]_{olefin}$$

Rearranging, taking logs and solving for d:

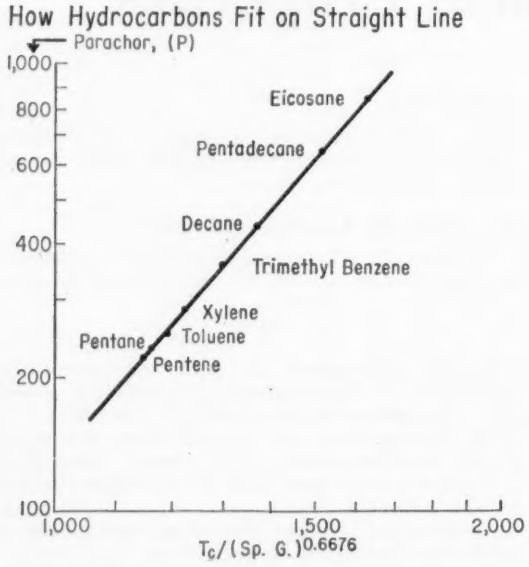
$$d = \frac{\log\left(\frac{T_{paraffin}}{T_{olefin}}\right)}{\log\left(\frac{Sp.\ G._{paraffin}}{Sp.\ G._{olefin}}\right)}$$

• Using this technique, several values of d were obtained from known data (A. P. I. Research Project 44). These values of d were checked by solving for the parachor $[P]$ and comparing with actual $[P]$ values. Value of d giving the smallest percent error was selected.

• After selecting d, the constants a and b were calculated from a plot of $[P]$ against $(T)/(Sp.\ G.)^d$ using the least squares method. The graph below, parachor as a function of $(T_c)/(Sp.\ G.)^{0.6676}$, shows how closely various hydrocarbons fit.

• Eqs. 1, 2 and 3 were determined for critical temperature T_c, boiling point at one atmosphere pressure T_1 and boiling point at 10 mm. Hg pressure T_{10}.

• After arriving at the first three equations, Eqs. 4, 5, 6 and 7 were obtained by substitution.



Accuracy Is Good

Reliability of these equations was checked with known data from the A. P. I. project mentioned above and the accuracy is shown in the accompanying table.

Using these equations, you can estimate the desired property of a pure hydrocarbon with close accuracy if you know any two of its properties of T_1, T_{10}, T_c, $Sp.\ G.$ or $[P]$.

Equations are given in logarithmic form because they have more than slide-rule accuracy. Use log tables for precise calculations.

One important point to remember: Limits of this method are pure hydrocarbons with normal boiling points between 400 and 1,400 R. and specific gravity between 0.5 and 1.0.

Acknowledgement

I would like to acknowledge my gratitude to Professor G. G. Lamb of Northwestern University under whom the preliminary work on this article was made as a Ph. D. thesis, in much broader scope.

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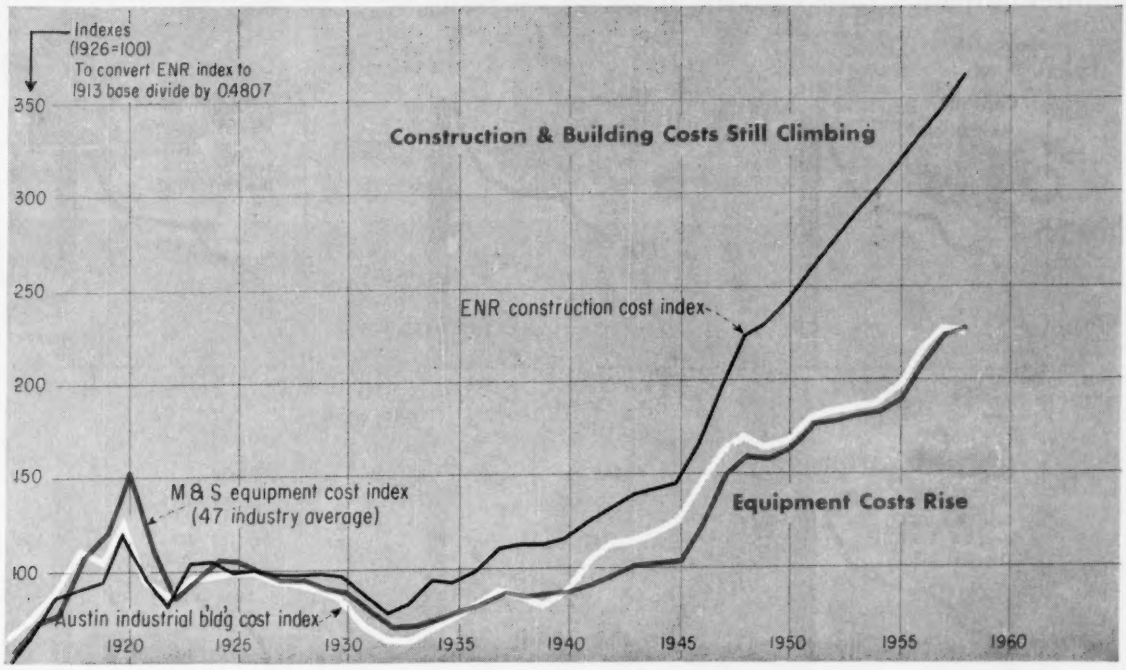


Costs Continue to Surge Upward

Even though equipment costs for the CPI experienced a drop in the second quarter of 1958, yearly averages once again reached new highs.

Charted above is a 47-industry average of equipment cost indexes prepared by the evaluation engineering firm of Marshall and Stevens, Incorporated of Illinois, Chicago 4. Basis for each of the individual indexes upon which the average is based, and the method of weighting the average, are described on pages 124-6 of our November 1947 issue, in an article by the late R. W. Stevens, partner of the firm.

Also plotted on the same grid are the Austin Co.'s index of industrial building costs, and the *Engineering News-Record* index of heavy construction costs.

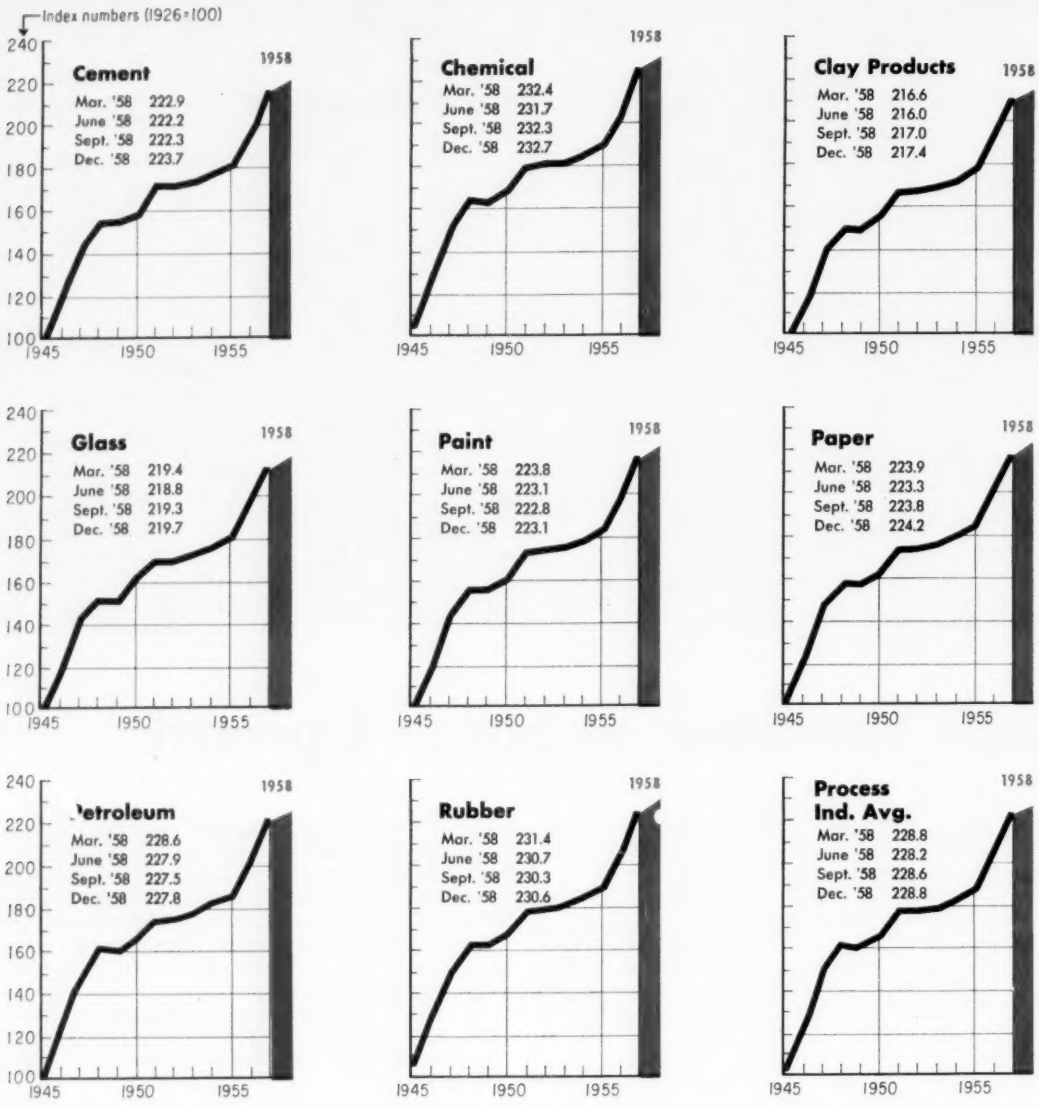
The M & S annual average indexes of comparative equipment cost for eight process industries and four related industries are chronologically tabulated below. Extending from 1913 through 1958, these averages are supplemented by quarterly figures in the individual charts on the next page.

A tabulation in the Process Equipment section of every issue during 1959 will show latest revisions for the quarters ending March, June, September and December.

Marshall and Stevens Annual Indexes of Comparative Equipment Costs, 1913 to 1958 (1926=100)

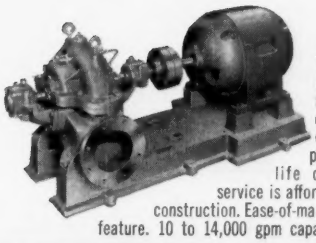
	1913	1916	1918	1920	1922	1924	1926	1928	1930	1932	1933	1934	1935	1936	1937	1938	1939	1940
Average of all....	57.9	62.8	109.7	153.3	85.5	105.3	100.0	96.5	87.0	66.1	69.4	74.6	78.0	81.6	88.3	84.4	84.3	86.7
Process Industries																		
Cement mfg.....	58.0	62.5	109.1	149.2	83.7	104.6	100.0	97.2	87.0	68.9	70.7	75.7	78.1	82.2	88.8	85.2	84.2	85.1
Chemical.....	59.0	63.0	111.9	150.5	82.5	105.6	100.0	96.9	82.0	77.6	70.9	75.4	78.5	82.5	88.2	84.4	83.4	84.3
Clay products.....	60.7	65.3	120.0	154.3	82.9	105.7	100.0	97.0	86.1	70.6	71.1	75.7	79.3	83.2	87.8	83.2	82.3	83.4
Glass mfg.....	58.7	63.5	112.1	151.1	83.7	101.9	100.0	95.9	86.6	69.4	71.2	75.4	78.5	82.6	88.0	83.4	82.5	84.0
Paint mfg.....	58.2	62.8	108.0	148.5	84.1	104.0	100.0	94.6	85.7	67.0	69.2	74.3	77.0	80.4	87.4	83.9	83.4	84.6
Paper mfg.....	60.4	63.4	111.8	152.6	83.1	105.6	100.0	96.8	86.5	67.2	69.9	75.4	78.5	82.7	88.1	84.8	83.7	84.8
Petroleum ind.....	58.9	64.1	113.0	151.5	82.7	106.0	100.0	97.1	86.2	70.1	70.6	76.0	78.7	82.6	87.8	83.3	82.1	82.5
Rubber ind.....	58.6	63.8	113.8	154.2	88.0	105.9	100.0	91.9	86.2	67.1	70.7	75.2	78.1	82.2	88.4	85.4	84.9	86.0
Related Industries																		
Elec. power equip..	59.1	64.3	114.2	152.2	83.6	106.0	100.0	96.9	86.1	70.1	70.7	75.5	78.7	82.7	87.9	84.3	83.7	85.3
Mining, milling.....	56.8	62.9	111.9	149.9	82.8	105.6	100.0	97.2	86.7	67.6	80.0	85.6	88.5	92.4	97.1	92.6	91.7	92.8
Refrigerating.....	59.3	63.2	113.5	153.5	83.9	96.1	100.0	97.0	86.4	70.0	71.3	75.4	78.9	83.0	87.5	83.0	81.8	82.7
Steam power.....	59.1	64.3	114.2	152.2	82.7	106.1	100.0	96.9	86.2	70.1	70.7	75.5	78.7	82.7	87.0	82.2	81.3	82.4

1958–Equipment costs increase again for all segments of the CPI

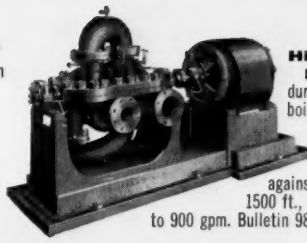


M & S Annual Indexes (continued)

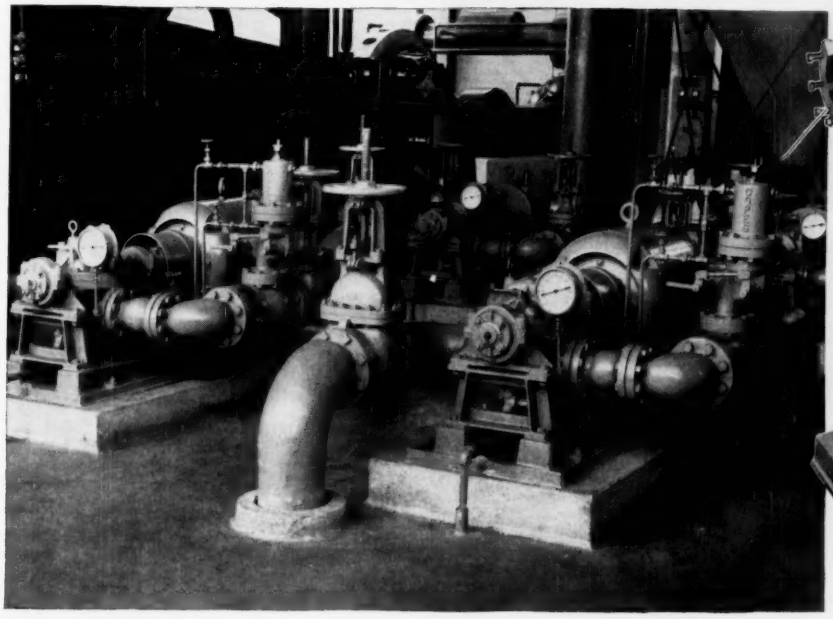
	1941	1942	1943	1944	1945	1946	1947	1948	1949	1950	1951	1952	1953	1954	1955	1956	1957	1958
Average of all....	92.6	99.6	100.5	102.4	103.4	123.2	150.6	162.8	161.2	167.9	180.3	180.5	182.5	184.6	190.6	208.8	225.1	231.3
Process Industries																		
Cement mfg.....	90.8	97.8	98.3	98.6	99.4	119.7	144.3	156.5	156.5	161.6	172.7	172.8	174.6	177.6	182.6	199.4	216.4	222.8
Chemical.....	93.3	102.0	103.1	105.6	106.5	126.8	151.5	164.5	164.5	169.6	180.7	181.1	183.1	186.2	191.5	209.1	226.5	232.3
Clay products.....	87.6	93.1	93.6	93.9	94.8	115.0	139.8	151.5	151.5	156.6	167.7	167.8	169.5	172.4	177.3	193.8	210.2	216.8
Glass mfg.....	88.2	93.7	94.7	96.5	97.4	117.6	142.3	154.6	154.6	159.7	170.8	171.0	173.0	176.0	180.9	197.5	213.8	219.3
Paint mfg.....	90.3	97.3	98.3	100.1	101.0	121.2	145.9	157.8	157.8	162.9	174.0	174.4	176.3	179.3	184.3	201.2	217.6	223.2
Paper mfg.....	90.5	97.5	98.7	101.3	102.2	122.4	146.9	158.1	158.1	163.2	174.3	174.7	176.6	179.6	184.6	201.5	218.2	223.8
Petroleum ind.....	88.2	95.2	96.7	100.0	100.9	121.6	147.1	160.9	160.9	166.0	177.1	177.6	179.7	182.8	188.0	205.4	222.2	228.0
Rubber ind.....	94.2	102.7	103.7	105.5	106.4	126.6	151.2	163.3	163.3	168.4	179.5	180.0	182.1	185.2	190.5	207.9	224.9	230.8
Related Industries																		
Elec. power equip..	90.5	96.5	97.5	99.3	100.2	122.9	150.0	166.1	166.1	171.2	182.3	182.8	185.0	188.0	193.3	211.0	229.2	235.2
Mining, milling.....	98.5	105.5	106.2	107.3	108.2	128.4	152.9	165.2	165.2	170.7	181.4	181.9	184.1	187.1	192.6	210.4	227.9	233.8
Refrigerating.....	89.0	95.8	97.0	100.2	101.7	125.7	163.2	176.6	175.8	185.2	200.1	200.7	202.8	204.8	211.6	234.3	254.2	260.8
Steam power.....	86.6	92.1	92.8	93.9	94.8	116.0	141.7	153.2	153.2	158.4	169.9	170.5	172.6	175.5	180.4	197.0	213.0	218.6

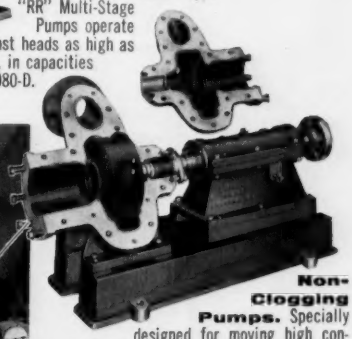


Clear Water Pumps. "Buffalo" Type "SL" Double Suction Pumps are designed for peak efficiency in clear water applications. A long life of economical service is afforded by their rugged construction. Ease-of-maintenance is a built-in feature. 10 to 14,000 gpm capacities. Bulletin 955-R.

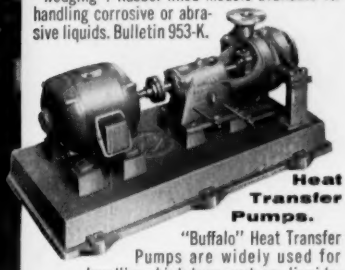


High Pressure Pumps. Offering efficiency, durability and dependability for boiler feed water and other clear water service, "Buffalo" Type "RR" Multi-Stage Pumps operate against heads as high as 1500 ft., in capacities to 900 gpm. Bulletin 980-D.





Non-Clogging Pumps. Specially designed for moving high consistency liquids, "Buffalo" Diagonally Split-Shell Pumps reduce down time, wear and "wedging". Rubber-lined models available for handling corrosive or abrasive liquids. Bulletin 953-K.



Heat Transfer Pumps. "Buffalo" Heat Transfer Pumps are widely used for handling high-temperature liquids. Ruggedly-built with special alloys, they utilize water-cooled bearings and packing. Efficient, single-suction, solid shell design. Write for application information.

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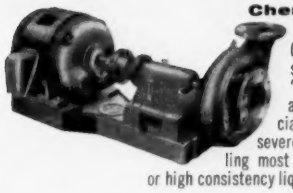

Chemical Liquid Pumps. Choose from 10 special types of "Buffalo" Pumps in a variety of trim. Specially engineered for severe service in handling most corrosive, abrasive or high consistency liquids. Bulletin 982-A.

What are your liquid moving needs? Chances are, you'll find the right pump for your job from the complete "Buffalo" line.

You can rely on "Buffalo" Pumps to perform with maximum efficiency and dependability. Their rugged construction insures a long life of maintenance-free operation. Economy, too, is a big factor. For example, interchangeability of parts is designed into "Buffalo" Pumps through standardization. This saves you valuable dollars in lower parts inventories.

Add to these advantages the helpful services of the "Buffalo" engineering team, and you have every reason to choose "Buffalo" Pumps for your particular needs. This engineering know-how is backed by more than 80 years of broad experience in solving liquid moving problems.

Whatever your pumping needs, call in your nearby "Buffalo" representative. He'll be glad to help you select the pump best-suited to your job. Or write us direct for full information and bulletins.

"Buffalo" Pumps bring you the "Q" Factor — the built-in QUALITY that provides trouble-free satisfaction and long life.

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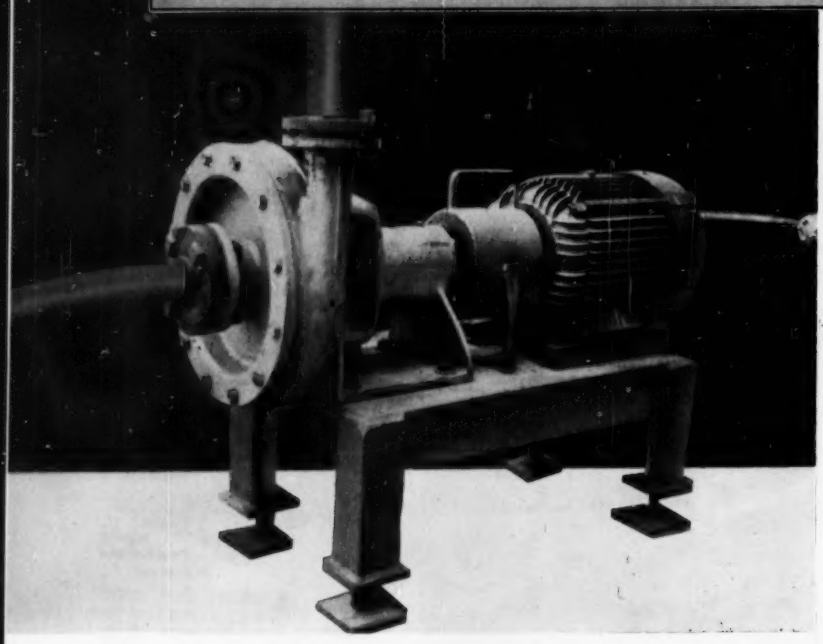
PRACTICE . . .

PLANT NOTEBOOK

EDITED BY T. R. OLIVE



Your own shop can easily build this base. It makes original installation easier and greatly facilitates pump relocation when necessary.

Versatile Base Aids Pump Installation

C. J. Slaybaugh*
W. G. Krummrich Plant, Monsanto Chemical Co., Monsanto, Ill.

Illustrated above is a versatile method of pump installation which eliminates the need for a conventional cast iron pump base and concrete pedestal. The complete pump, motor and base can be assembled in the shop before moving to the job site. This leaves only power wiring, piping and manipulation of the jack bolts to be done during installation in the field.

The body of this fabricated pedestal can be made from heavy steel channel with angle iron legs. The feet, jack bolts and jack nuts should be of stainless steel to resist corrosion, since rusting of the jack bolts will make future adjustment time-consuming and difficult.

The versatility of this installation is one of its most important advantages, owing to the possibility of changed products and processes. The whole unit can easily be relocated without breaking out a concrete pedestal, or leaving one to take valuable floor space. Such an installation also lends itself to better housekeeping since it can readily be

* Present address, University of California, Berkeley, Calif.

Coming March 23: Add a Jet to Up Compressor Pressure

By V. V. Fondrk, Winner of the January Contest

★ How Readers Can Win

$50 Prize for a Good Idea—Until further notice the Editors of *Chemical Engineering* will award $50 each four weeks to the author of the best short article received during that period and accepted for Plant or Process Design Notebook.

Each period's winner will be announced in the second following issue and published in the third or fourth following issue.

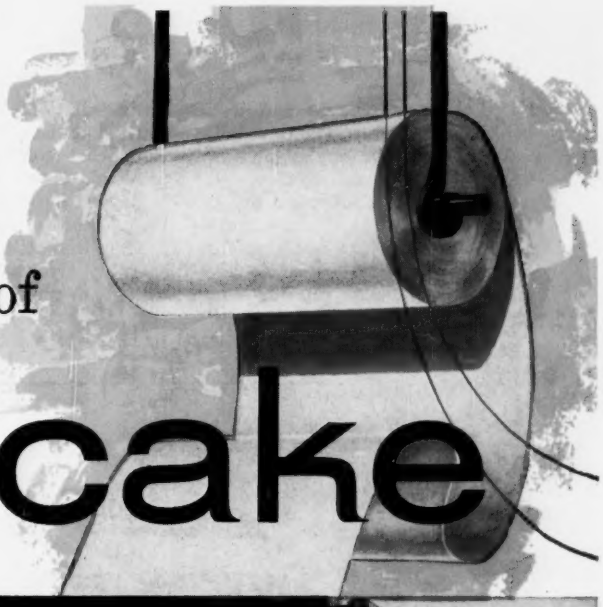
$100 Annual Prize—At the end of each year the period winners will be rejudged and the year's best awarded an additional $100 prize.

How to Enter Contest—Any reader (except a McGraw-Hill employee) may submit as many contest entries as he wishes. Acceptable material must be previously unpublished and should be short, preferably not over 500 words, but illustrated if possible. Acceptable nonwinning articles will be published at space rates ($10 minimum).

Articles should interest chemical engineers in development, design or production. They may deal with useful methods, data, calculations. Address Plant & Process Design Notebooks, *Chemical Engineering*, 330 W. 42 St., New York 36, N. Y.

What it means to be the world's largest producer of

salt cake



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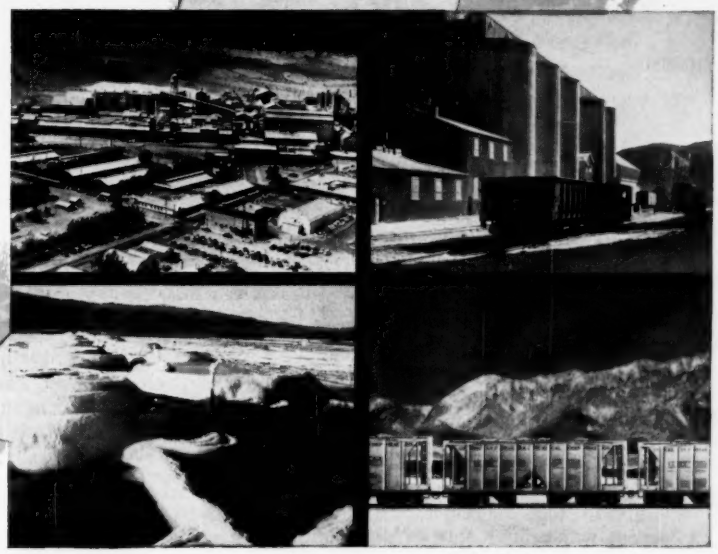

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Look for an early announcement of the start-up of American Potash & Chemical Corporation's new sodium chlorate plant at Aberdeen, Mississippi, constructed to supply the rapidly growing southern pulp and paper industry.

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hosed clean and the need to hose behind it is virtually eliminated.

When installation is out-of-doors, there is no need to go below the frost line with a pump foundation. If the pedestal is set on a small 6-in. thick concrete pad, the unit can easily be adjusted to relieve any pipe stresses due to frost heaving of the pad.

Comparing costs, we find that an installation of this type costs somewhat less than a conventional cast iron base and concrete pedestal. However, if relocation is needed subsequently, the saving will be substantial.

The versatility and housekeeping advantages of this unit make it a "must" for pilot plants, but it should also be considered for general plant use.

Simplify Your Figuring on Foils

W. R. Botham
Heighington, County Durham, England.

In manufacturing plastic and metal sheets and foils it is often necessary to obtain the weight, thickness or total length of material in sheet or roll form. Also, it may be desirable to keep a running check on the specific gravity during the production of plastic sheet, knowing the weight of a known volume. This serves to monitor product uniformity and mixing efficiency in the process line.

One problem is that in calendering plastic sheets or foils, the true thickness cannot be measured with a micrometer because the instrument will either indent the soft material, or will ride over surface irregularities, thus giving false readings.

A way around this difficulty is to cut a number of 2-in. dia. disks from the material with a circular press tool. When the disks have been weighed on a sensitive torsion-spring or analytical balance, their average weight in milligrams is used in the formula:

$$\text{Thickness (0.001 in.)} = \frac{\text{Wt. (mg.)} \times 0.0194}{\text{Sp. gr.}}$$

It is not advisable to combine the specific gravity into the constant since in that case the operators may lose sight of the fact that specific gravity does enter into the formula, and use it erroneously after a change in composition.

When the material is in the form of cut sheet and we want to calculate the weight, then:

$$W = \frac{\text{Sp. gr.} \times L \times B \times T}{27.75}$$

where W is weight, lb.; L is length, in.; B is breadth, in.; and T is thickness, in. For very thin sheet, where we desire the weight w in ounces:

$$w \text{ (oz.)} = \frac{\text{Sp. gr.} \times L \times B \times T}{1.7344}$$

Conversely,

$$\text{Sp. gr.} = \frac{1.7344 \times w \text{ (oz.)}}{L \times B \times T}$$

When the material is in roll form, the roll diameter, number of layers, thickness, length and weight can be related in a number of formulas:

$$D_2 = D_1 + 2NT$$

and

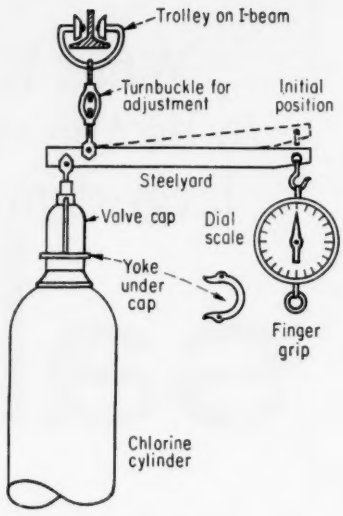
$$N = (D_2 - D_1)/2T$$

where N is the number of layers; D_1 is the mandrel diameter and D_2 the outside roll diameter, both in.; and T as before is material thickness, in. Since the length of the first layer is $\pi (D_1 + 2T)$ and the length of the Nth layer is $\pi (D_1 + 2NT)$, then the total length L, in in., on the roll is the sum of all the layers, or:

$$L = \pi [ND_1 + NT (N + 1)]$$

Finally, we can find the weight of material on the roll as W, lb., by making use of the difference $(A_2 - A_1)$ which is the area of the cross section of the full roll, in sq. in., less the mandrel cross section area. Where B, in in., is the roll breadth:

$$W = B (A_2 - A_1) \times 0.03604 \times \text{Sp. gr.}$$



Easy Weigher for Your Chlorine Cylinders

J. K. Paul
Oak Ridge, Tenn.

In a small installation where there are few chlorine cylinders to be weighed, standing them on a platform scale presents no very serious problem. But where there are a large number to be checked, and especially where a manifolded battery of cylinders must be weighed from time to time, then something more is needed to speed the operation.

Shown above is a handy weighing device consisting of a combined scale and cylinder lifter carried on a trolley on an I-beam running along over the bank of cylinders.

The weighing lever shown can be fabricated for the purpose or it can be a steelyard scale, to which is attached a special yoke lifter. With a capped cylinder the protective cap can be loosened just enough to slip the yoke under it. If the cylinders are connected on-line by means of flexible connections, then the yoke can be made to engage the connection.

To weight a cylinder attach the yoke and, with the lever in the initial position, pull down on the dial scale enough to lift the cylinder from the floor. The scale reading, times the multiplying factor of the lever, then gives you the correct weight of the cylinder.

Working wonders out of waste!

This quadruple-effect evaporator concentrates antibiotic liquids for E. R. Squibb & Sons, New Brunswick, N. J. Developed for the handling of streptomycin waste, it demonstrates Swenson's ability to help advance the production of new pharmaceuticals put into service for humanity.

Send for Processing Profiles, the authoritative new color booklet of performance reports! It shows Swenson products on the job . . . bringing higher efficiency and quality to all the processing industries. Remember, what Whiting's Swenson Evaporator Division has done for others can be done for you. *Swenson Evaporator Company, 15669 Lathrop Avenue, Harvey, Illinois.*

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How Engineers Can Save on Income Tax

As the Ides of April draw near this year, engineers can take advantage of some recent rulings that will save them a buck, or two, on income-tax day.

You may be able to save some money on your income tax this year. Internal Revenue Service has some new regulations that can be applied to increase the deductions that engineers may claim as business and professional expenses. Also, if you take a long hard look at some of the older regulations, you may find some deductions that you never thought of taking.

Many references are available to guide you, as an individual taxpayer, through the treacherous ordeal of filling out your Federal income tax return. Uncle Sam himself sells one for 35¢ that's mighty good. J. K. Lasser's, "Your Income Tax, The Original, most widely used tax guide in America," is now in its 22nd year of publication at a price of $1.95.

We can't hope to—nor would we ever want to—replace these revered favorites. In fact, our own well-thumbed copies of these references will be invaluable assets in the weeks to come. What would be mighty handy, though, is a guide specifically directed to the engineer. What peculiar characteristics of his professional employment conditions might make some differences in how he fills out Form 1040?

This is the question that we put to the tax consultants of Trav-ex Co., Inc., 550 Fifth Avenue, New York. The discussion that follows is a mingling of their suggestions and *CE's* interpretations.

One more bit of preliminary explanation before we begin, though. We will only consider the engineer who is not primarily in business for himself. His main source of income is from his employer. If he does consulting work in his spare time, it does not constitute the major part of his income.

Also, let's assume that the engineer we are talking about itemizes his deductions on Form 1040, rather than taking the standard 10% deduction on Form 1040A. (Note that this year Form 1040A may be used for reporting incomes up to $10,000, and a standard deduction of up to $1,000, instead of the previous upper limit of $5,000 with a $500 deduction.

How to Report Business Expense

First item on the agenda is the way in which you report business and travel expenses. You'll remember that last year

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Antimony Trifluoride Sublimed
Barium Fluoride
Bismuth Fluoride
Boron Trifluoride
Boron Trifluoride Complexes
Cadmium Fluoborate
Chromium Fluoride
Copper Fluoborate
Fluoboric Acid
Fluorine Cells
Fluorinating Agents
Frosting Mixtures
Hydrofluoric Acid Anhydrous
Hydrofluoric Acid Aqueous
Hydrofluosilicic Acid
Lead Fluoborate
Lithium Fluoride
Metallic Fluoborates
Nickel Fluoborate
Potassium Bifluoride
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Sodium Fluoborate
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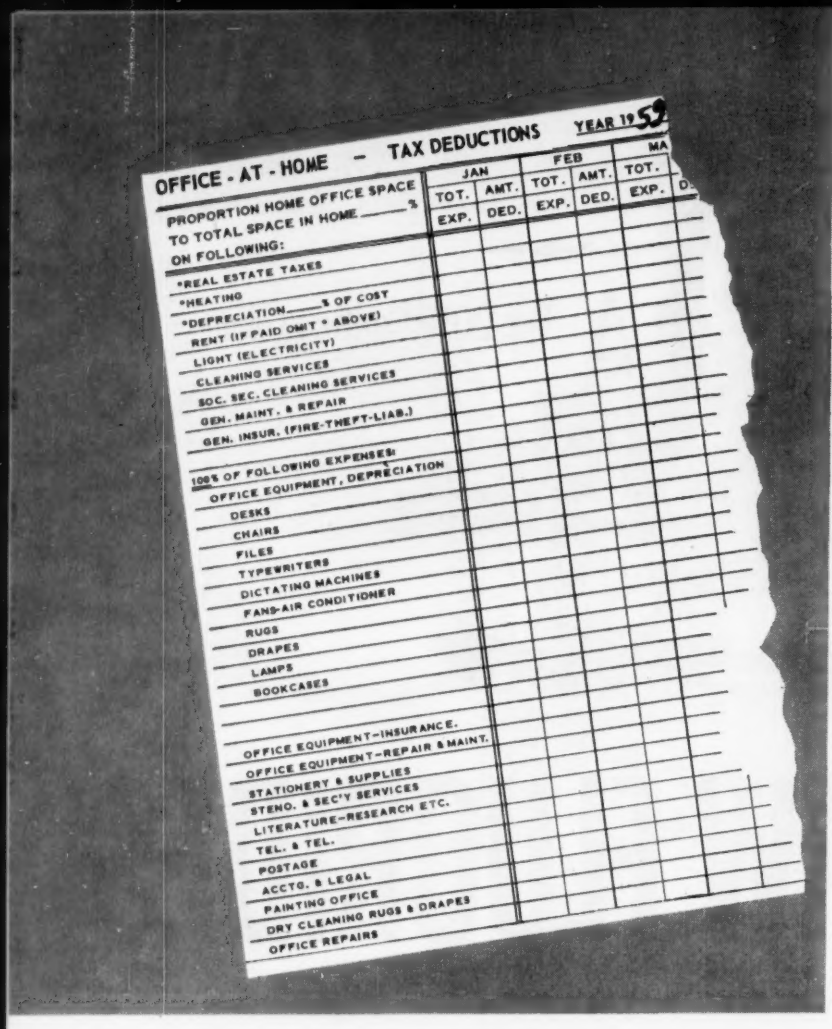


there was an aborted attempt to have all such expenses itemized in detail and listed on the form in a separate line. This line does not appear on the form this year.

Here's how things stand for those of you who regularly account to your employer for business and travel expenses:

• If your employer's payments to you equaled your expenses, forget the whole thing. You need not report these items on your return either itemized or in total amount.

• If your expenses exceeded your employer's payments to you, get ready to itemize everything if you wish to claim a deduction for the amount of excess expenses. Form 2106 is available in any Internal Revenue office for use in listing these expenses.

• If, by any chance, your employer gave you more than your business expenses, the excess should be reported as income on Line 5 of Form 1040 and identified as "excess reimbursements."

A handy booklet is now on the market for recording travel and business expense week-by-week. It is copyrighted by the Trav-ex Co., Inc., and sells for $1/copy. Since to take advantage of the deductions permitted by the Internal Revenue Code you must be able to prove each item claimed, a record-keeping system such as this might be well worth your consideration.

Do You Take Work Home?

You may be able to cut a sizable chunk off your income tax if you take work home with you at night or over weekends, and if you have some special place set aside in your house or apartment which you actually maintain as an office-at-home.

Use of an office-at-home entitles any business or professional man to deduct the same proportion of the general expenses of his home which the space used for office-at-home bears to the total space of the home. For example, if you use one room of a six-room house as an office, deduct 1/6th.

Internal Revenue Service has ruled that such deductions are permitted if the work done at home is "ordinary, necessary and reasonable, as well as proximate to the business activities of the taxpayer."

If the taxpayer is an employee, the above requirements can be supported by a letter of the employer to the effect that compensation paid to the taxpayer contemplates additional work at home to efficiently prepare for and carry out the duties of the taxpayer's job.

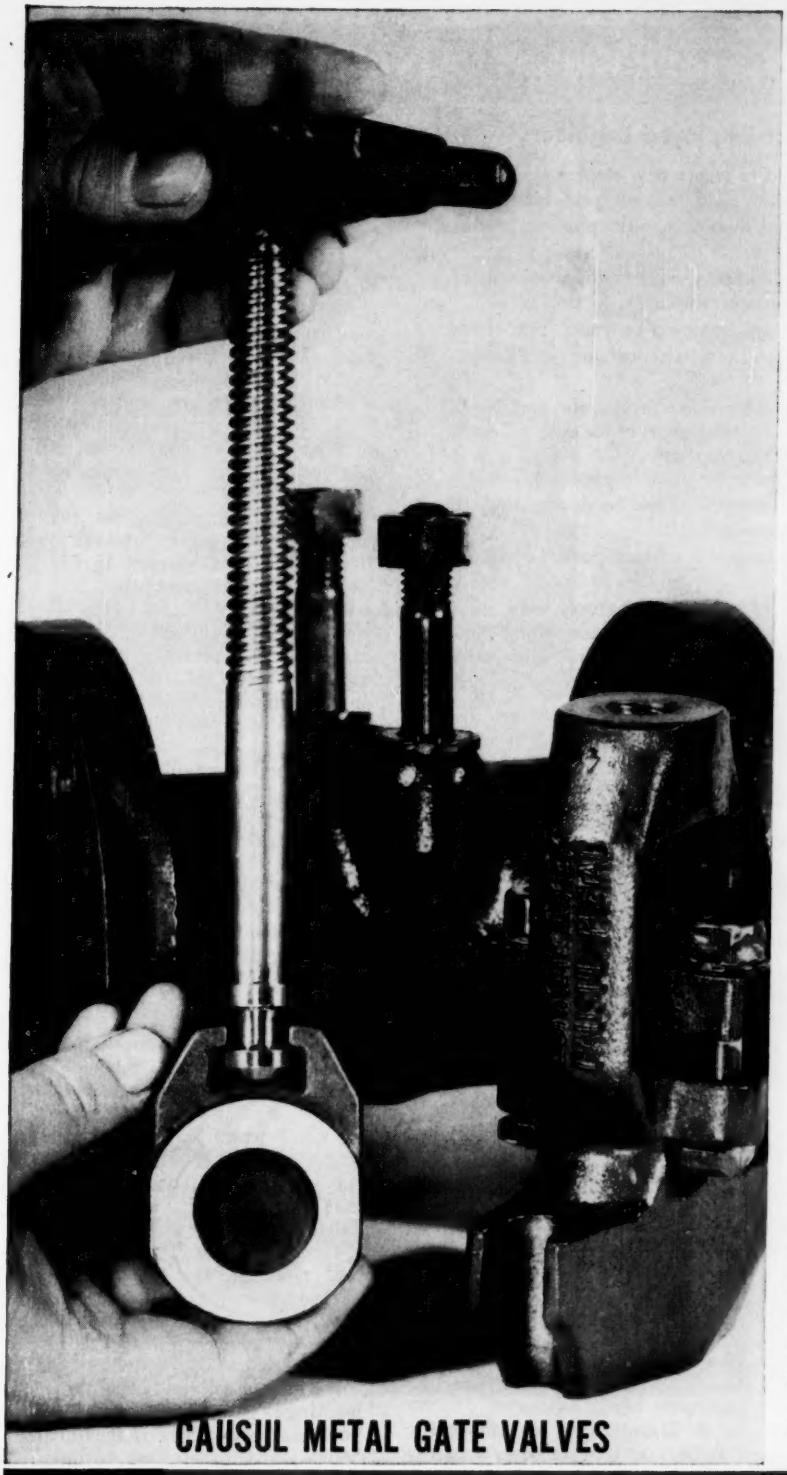
Expenses of operating an office-at-home are deducted directly from the taxpayer's income, and if he so wishes the taxpayer may still claim the standard deduction. If the taxpayer does not take the standard deduction and decides to itemize his deductions, he may then deduct any remaining portion of taxes on his home and interest on his mortgage which he has not already deducted as part of his office-at-home expenses.

We have shown above a part of the copyrighted Trav-ex checklist for recording office-at-home expenses. Note that with expenses such as taxes, interest on mortgage, electricity, general maintenance and repair, heat, cleaning services, social security taxes for servants and general insurance, you deduct a proportionate share as office-at-home expenses in the ratio of the space used for your office to the space in the entire house.

However, for expenses such as depreciation on office equipment, furniture, files, rugs, drapes, lamps, bookcases; expense of insurance on office equipment; stationery and supplies; secretarial service; telephone, postage; and painting of the office area, you may deduct 100% of the expense for income tax purposes.

This procedure will provide tax savings for the purchase of new equipment or modernization of the office-at-home generally.

Note that IRS has stated that deductions for office-at-home expenses are permitted if the work



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Tax-Deduction Checklist for Employed Engineers

1. Employment agency fee paid to secure new employment.
2. Contributions and assessments paid to your professional societies, including your annual dues and subscription to professional journals.
3. Cost of attending meetings and conventions of your professional group, if not reimbursed by your employer.
4. Damages, court costs and legal fees paid by you in connection with defending yourself in civil lawsuits concerning your profession.
5. Deductions from your salary for damage to your employer's property in the course of your employment; or for cash collected by you for your employer which you lost.
6. Cost of instruments or apparatus essential to your employment. If the useful life is long, the expense should be depreciated. If useful life is short, deduct entire amount.
7. Cost of entertaining your assistants at dances, parties and company picnics.
8. If you wear special clothes at work, and you only wear these clothes while you are on the job, the cost of these clothes and the cost of laundering them is a deductible item. Preferably, you should have a locker at the plant or office where you store these clothes.
9. Cost of safety shoes, if not reimbursed by your employer. Same for safety glasses.
10. Legal expenses paid by you for drawing a contract of employment.
11. Cost of business and professional magazines.
12. Substitutes paid by you.
13. Expense of patent infringement judgments against you.
14. Fee for your professional engineer's license.
15. Repairs to professional tools or instruments.
16. Books purchased wholly for use in your profession if their useful life is short. You'll probably have to depreciate a book like Perry's Handbook over several years.

done at home is "ordinary, necessary and reasonable." You must actually maintain a separate area in your home which you use as office space.

To establish such a claim, the office-at-home may contain a separate business phone, files, drafting table, desk, work table, lighting equipment, engineering books and data, technical magazine files, supplies, office stationery and perhaps a typewriter or desk calculating machine.

Cost of Your Education

We have already reported on a change in the tax rulings this year that allows engineers to deduct as professional expenses the cost of maintaining or improving skills required in their employment (*Chem. Eng.*, Oct. 20, 1958, p. 172).

After the item was printed we received several letters from readers asking for further details. Here's what the official instruction pamphlet for filling out Form 1040 says on p. 10:

"Expenses for education may be deducted if the education was undertaken primarily for the purpose of:

a. Maintaining or improving skills required in your employment or other trade or business, or

b. Meeting the express requirements of your employer, or the requirements of applicable law or regulations, imposed as a condition to the retention of your salary, status, or employment, but only if the expenses are to meet the minimum education required.

"Expenses incurred for the purpose of obtaining a new position, a substantial advancement in position, or for personal purposes are not deductible."

The instruction then explains how to report the expenses and tells what is required of the taxpayer. Then the instruction concludes this way:

"If the education was required by your employer, a statement to that effect from him would be helpful."

We want to emphasize that the statement from your employer is not absolutely required. If you decide on your own that you ought to take a course in Reaction Kinetics, for example, because it is necessary now to maintain your skill in chemical engineering, we would think that this would very well be a deductible expense.

Another important point to remember is that the ruling allows you to file for all such expenses back through 1955. In making the ruling IRS explained that the new interpretation removes the distinction previously drawn between self-employed persons and employees such as teachers and engineers.

The Good Old Standbys

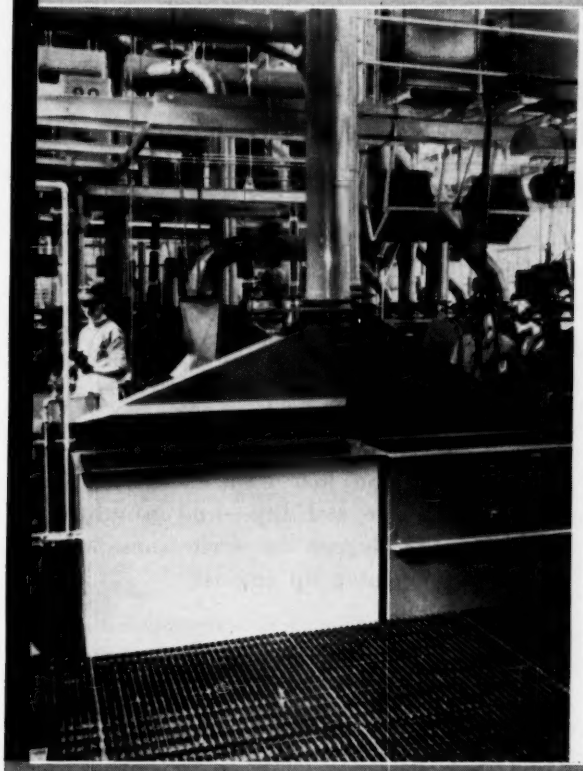
Although most of the emphasis in this article has been on new and unusual ways in which you can save on your income tax, we don't want to minimize the potential savings available in the good old standard deductions that engineers have been entitled to for many years.

In the box above we've assembled a checklist of deductions that seem to apply to most engineers. Among the more obvious ones are: dues paid to AIChE and the cost of attending its committee meetings and national meetings, if not reimbursed by your employer; cost of technical books and subscriptions to business, professional and technical magazines; license fees for your professional engineer's license; and even the cost of repairing your trustworthy slide rule should you happen to drop it on the floor.

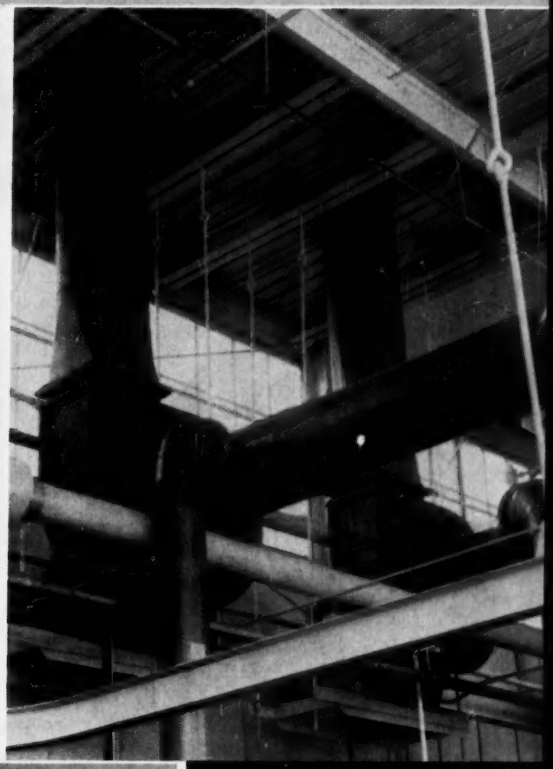
Good luck on April 15th.

Industrial Plastic Fabricators, Inc. proves . . .

Complete Boltaron 6200 installation... ducts, tanks, hoods, blowers.



Boltaron 6200 ductwork & fans with stacks going through the roof.



Boltaron® 6200

is the best answer for handling chemical & industrial fumes

Boltaron 6200 IS BEST BECAUSE:

- Protects against most corrosive fumes and liquids in any combination.
- Resists build-up of residual materials from corrosive fumes and liquids.
- Solid Boltaron has no coatings to peel or chip—does not require recoating or repainting.
- Chemically inert.
- Non-toxic, imparts no taste or odor.
- Can be welded, bolted, threaded, milled, ground, buffed and polished.
- Non-sparking—will not support combustion—handles fumes and liquids.
- High dielectric strength.
- Extremely lightweight—non-porous—and smooth surface.
- Tensile strength is 8000 psi.
- Can be joined by heat welding, solvent cementing, and threading.

Many progressive U. S. manufacturers are using IPF systems fabricated from Boltaron 6200 to solve a wide variety of industrial problems, especially where corrosive fumes and liquids have been extremely costly to handle. In every case Boltaron 6200 systems have increased operating efficiency—decreased operating costs.

For further information on performance-proven fume collectors and exhaust systems write: Industrial Plastic Fabricators, Inc., Endicott Street, Norwood, Mass.

GENERAL® PLASTICS
The General Tire & Rubber Company

THE GENERAL TIRE & RUBBER COMPANY • Bolta Products Division • Lawrence, Mass.

This new signal system uses color and position to tell you just what hazards exist—fire, health or stability—and numbers to identify the degree or seriousness of the hazards you come up against.

See Hazards at a Glance

J. J. DUGGAN, Director of Safety and Fire Protection, Union Carbide Chemicals Co., S. Charleston, W. Va.

Your actions and habits are controlled by signals that are visual, audible or habit. By habit we mean: You receive guidance from communications and this guidance becomes habit-forming. As soon as you acquire a habit, you tend to follow it until something changes your concept of the directional methods governing your way of doing things.

This very basic principle of communicating is used by safety people to define and explain hazards. Now, hazards in the chemical industry are considerably different from those you come up against in home or traffic safety. It's pretty obvious when something is too heavy or too sharp. You can observe these things.

Moving into the field of chemical materials, ever increasing in number, you find the thing safety men dread. That is, the hidden hazard—a hazard you can't see; a hazard not obvious to your senses. You can't say, for instance: All powdered materials explode when heated; all liquids when raised in temperature give off fumes harmful to our health; or all black materials burn when lighted with a match.

It's unfortunate that it's difficult to distinguish between arsenic and aspirin; between sulfur and TNT; between a physically normal material and a radioactive material. These are the areas—the hidden hazards—you must nail down in identifying fire hazards.

There's been a great deal of effort and study by many groups. There is an answer, and a good one, in this business of uncovering hidden hazards of materials whose names you can't remember, let alone the hazards involved in each. Something can be done to bring these hazards out in the open; to spell out the hazard inherent in the material.

It's necessary to put a sign on them—a warning signal—so anyone who moves, stores, processes or handles these materials knows immediately what hazards, if any, are presented by that material.

In addition to the type of hazard presented by physical and chemical characteristics, it's also important to identify the degree or seriousness of the hazard.

Colors, Numerals and Shapes

Looking at the experience of others who have tried to classify and indicate types of hazards, color is invariably recognized as a good classification medium. Also, numbers, like colors, are universal in meaning and can indicate severity or degree. You're all used to numbers. Shapes can also be used as an indicator since they too are universal and mean something.

Color to designate type; numbers to designate degree; and shape or position for the color blind. This isn't much of a departure from a well worn path. Only a recombination of elements from experience to

Lubrication News

PROFITABLE IDEAS ON THE LUBRICATION OF CHEMICAL PROCESS EQUIPMENT

PLANT REDUCES LUBRICANTS FROM 27 TO 7—PROCESSING IS IMPROVED

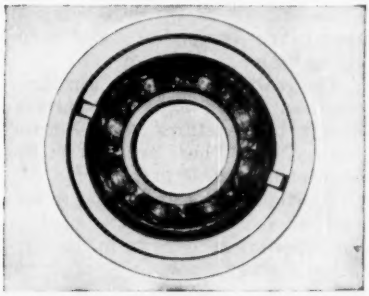
Multi-purpose greases cut lubrication costs

One plant in the basic chemicals industry has eliminated 20 lubricant specifications from its inventory. The maintenance supervisor reports that the plant is operating more efficiently than it ever did before.

This is just one example of a cost-cutting trend to fewer lubricants in chemical plants. Multi-purpose greases are replacing numerous specialty lubricants—even in areas of high heat, exposure to water or moisture, and oxidation or corrosion.

How multi-purpose greases cut costs

The most important cost-saving advantage of using multi-purpose greases is this: the man who lubricates equipment always uses the right grease. He doesn't have to choose the lubricant from among several drums. As a result, there's less chance of putting the wrong lubricant into a valuable piece of process equipment.



Bearing stopped in motion by high speed photography. Note how grease completely floods retainer and moving parts.

In addition, less lubricating equipment is required to apply multi-purpose greases. Perhaps only one grease gun will be needed for one entire part of a plant. And—there can be no confusion about which applicator goes with each lubricant. As a result, lubrication rounds take less time—labor costs go down.

Use of a multi-purpose grease also saves time in training lubrication crews, by making it easy to select the proper lubricant. It's easier, too, to set up a centralized, automatic lubricating system when only one lubricant is used.

Grease fully protects bearings

Multi-purpose greases are now available that completely lubricate all types of bearings and sliding surfaces. They also seal against dust, water contamination, or corrosive products and atmospheres.

These multi-purpose greases contain inherent properties that make them satisfactory for all except extreme or unusual operating conditions. They have good resistance to water washing. They will absorb limited amounts of water without change in consistency. They provide good resistance to oxidation. Maximum continuous usable temperature can be as high as 300° F. Stability on working is in many cases excellent.

New movie shows how grease tests predict performance in plant

How well will a grease stand up under pressure? How long will it resist washing by water? How much can it take before it shears or leaks? What happens under conditions of extreme cold? Heat?

A new movie, "Shear Magie," reveals how laboratory tests anticipate what happens when a grease is exposed to these conditions in the plant. Described are the "4-ball load test," which measures how well a grease stands up under pressure; water washing and rusting tests; leakage tests; and tests for resistance to heat, cold and wear.

The movie also shows how greases of all kinds are made, and explains the mechanics of grease lubrication.

A showing of the 25-minute sound and color movie can be arranged at your plant. Attach coupon at right to your letterhead.

Spray system protects open gears against abrasion by dust, dirt

Open gears have long been lubricated by applying heated grease with a hand paddle. This has to be done when the gears are not running. Now, a spray application method makes it possible to lubricate open gears without machine downtime—and without sacrificing the complete protection required, especially in areas of excessive dust and dirt.

Another advantage of spray application is that it keeps the gears cleaner, less likely to foul up with contaminants.

The method described permits use of either manual or automatic spray applicators.

Management Practices Book

This guide to organized lubrication can help you achieve important savings in maintenance costs. It discusses methods that help raise production, extend parts life, cut downtime. For free copy, use coupon below.

THE TEXAS COMPANY
Dept. CE-CP-10
135 East 42nd Street
New York 17, N. Y.

I am attaching my company letterhead to this coupon.

- ☐ Send a copy of Management Practices that Control Costs via Organized Lubrication.
- ☐ Send more information on the movie, "Shear Magic."
- ☐ Ask a Texaco Lubrication Engineer to call at my plant.
- ☐ Can you help solve the attached lubrication problem?

Name_____

Title_____

TUNE IN... Metropolitan Opera Radio Broadcasts
CBS Every Saturday Afternoon

solve a clearly defined problem. That problem: Classification and identification of hazards by a simple visual signal system.

This classification goes like this: Use what exists—things people are familiar with. For a fire hazard, use red since this ordinarily stands for flammability or flammable materials. For stability, use yellow—a color usually associated with caution. Then, since the two primary colors of red and yellow have been used, the third primary (blue) is used for the health hazard.

This gives a three-color scheme to identify type of hazard, but it doesn't indicate degree of hazard or shape or positioning of the signals.

There's a definite advantage in using shapes to identify hazards.

First—Shapes permit people who can't distinguish colors to still respond to a signal.

Second—Shapes assist in identification where visibility is obscured by atmospheric conditions or where colors become faded.

Third—Shapes or uniform positioning eliminates confusion with other numerical identification systems, such as building or tank numbers.

A further simplification is colored numerals. These provide a simple signal, economical to apply and distinct in character from other types in use. At the same time, it uses only familiar mediums.

For uniformity, numerical colored signals are positioned from left to right by health, fire and stability. Fire hazard signal (red numeral) is positioned above and between the other two. Combined, the signal appears in a diamond-shape formation.

Spell Out the Health Hazard

Degree of health hazard can be classified as: Low, minor, sub-major and major. Here, rely on doctors and hygienists for classification.

Doctors can adequately indicate whether there's any residual injury after exposure. They've classified a great many materials by simply indicating whether there's residual injury after exposure if treated or not treated promptly. In this instance, precision isn't required.

If the health hazard causes a man to put on a fresh air mask or pair of goggles or protective clothing, the major portion of the job of protection is taken care of.

Certain materials are normally considered nontoxic. However, no material is completely nontoxic or noninjurious to health. Any reduction of oxygen content in the air is bound to affect people, although permanent injury may not result.

Position of the health signal is first in sequence and at the left of the combined signal.

Fire: Use Flash Point

Now, what about the fire hazard? You're familiar with the definition of flash point and agree that it's an adequate measure of fire hazard with flammable materials. Also, that low flash-point materials represent the greatest hazard from the standpoint of starting a fire.

Flash points are easily determined or available in text books or handbooks. Manufacturers of the materials are also a good source for flash-point data.

In spelling out the degree of fire hazard, start with noncombustible materials as No. 0. Then indicate materials with flash points above 140 F. as No. 1. Materials with flash points between 100 and 140 F. are more hazardous, as indicated by No. 2. Category No. 3 includes those igniting between 73 and 100 F. Hazard from these is increased because of the possibility of ambient atmospheric temperatures being in that range—supplying vapor readily ignitable.

The really tough babies are those you can't even expose to atmospheric temperatures safely—those below 73 F. These are No. 4: the highest flammable hazard.

Position of the fire signal is second in sequence (in the center) and above the other two in the combined signal.

Stability: Yellow for Caution

Most materials are normally stable and don't react with water or other extinguishing mediums. To that classification, as far as stability is concerned, give the No. 0. It may or may not be necessary to include zero in this classification.

Starting off with:

No. 1—Materials normally stable under standard conditions.

No. 2—Materials that react with water. This group is most important to firemen. They always have the question of what extinguishing medium to use. There are many places where water has an adverse effect; where applying water spreads the fire and extends damage.

No. 3—Affixed to self-reactive materials. Materials that react with

How to cut costs and get longer service from rubber products

Specify rubber goods made of Du Pont neoprene or HYPALON®! They outlast products made with ordinary rubber. For example:

HYPALON lined pump casings show no evidence of corrosive attack after one year service in caustic soda-chlorine manufacturing unit. Natural rubber failed within two months.

Neoprene pipe linings in cooling water return line in a refinery have served for over two years. Other linings failed within a year when exposed to water containing 18,000 ppm. salt and traces of oil.

HYPALON hose has carried hypochlorite since May, 1954. Other hose broke down in a few months.

Neoprene sleeve valves have been exposed to 265° F. steam and submerged in soda ash storage tanks since 1955. Maintenance costs have been reduced.

Maintenance products of neoprene and HYPALON offer economy . . . longer service per dollar, reduced replacement costs, minimum downtime.

Neoprene and HYPALON assure lasting durability and excellent resistance to a wide range of deteriorating factors. Neoprene is a versatile synthetic rubber, with good resistance to oils and greases, most organic and inorganic chemicals. HYPALON is a special-purpose synthetic rubber which is heat-resistant, ozone-proof and impervious to most oxidizing chemicals.

Your local rubber goods distributor carries maintenance products of neoprene and HYPALON. He can recommend the right product to meet your needs. Call him soon. For more information write for "Du Pont Elastomers in Industry," E. I. du Pont de Nemours & Co. (Inc.), Elastomer Chemicals Dept. CE-2, Wilmington 98, Del.

Rubber products of neoprene and HYPALON last longer

DU PONT
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SYNTHETIC RUBBER

NEOPRENE
HYPALON®
VITON*
ADIPRENE®

*Trademark for Du Pont Synthetic Rubber

Better Things for Better Living . . . *through Chemistry*

Carbide's Chemical Classification

	Health	Fire	Stability
Acetone	2	4	1
Benzene	4	4	1
Butanol	3	2	1
Chlorine	4	0	1
Dowtherm	2	1	1
Ethanol	2	4	1
Gasoline	3	4	1
Heptene	2	4	1
Lub Oil	2	1	1
Nitric acid	4	0	1
Pentane	3	4	1
Toluene	4	4	1

themselves in the presence of contaminants or are temperature sensitive. Temperature-sensitive materials react violently, sometimes with detonating force, if heated sufficiently or contaminated with materials that react with it.

No. 4—Contains materials that detonate or explode when exposed to abnormal temperatures and pressures or subjected to shock. Such materials are the most hazardous so make sure they are carefully identified.

The yellow stability signal is positioned on the right of the combined signal and on the same horizontal plane as the blue health signal.

Classification Isn't Hard

Putting all three numerical and color classification signals together indicates, at a glance, what the primary hazard is and the severity of each category.

At this point, let's clarify a condition—what do you do with noncombustible materials that are toxic and reactive? In this case, the fire hazard is indicated by No. 0; preferably a green zero. If a health hazard is present or if the material is unstable or reactive with water, as an example, it carries the classification outlined for such characteristics.

Typical classifications of materials handled by Union Carbide Chemicals Co. are shown in the accompanying table.*

Consider How People React

You must look into the problem of how people will respond to a signal. You must consider the effect of this signal on people and how it causes them to react.

Take your case, perhaps as a process supervisor, a professional person quite familiar with the chemical involved. Compare it with the operator looking at the same signal on a piece of processing equipment.

To you, the signal spells out: This material is a serious health hazard and you must take steps to protect the health of your people and customers. To the operator, it means a gas mask when dealing with the material.

In other words, you're thinking about your people, the employees under your supervision, protection of the company's property and protection of your customers. The operator is thinking about self-preservation and in each case, the signal accomplishes its purpose.

Then, there's the case where you recognize the main hazard as flammability; the material has a low flash point. You are thinking about restricting smoking, restricting open flames or anything causing the material to ignite.

The operator is thinking about where the fire alarm box is, what kind of extinguisher to use and what precautions to keep it from catching fire. Again the signal accomplishes its purpose.

In the instance where the main hazard is instability, you visualize the material can explode for no readily apparent reason; a slight increase in temperature or pressure can cause a chemical reaction that's disastrous.

The operator is looking at the same signal: watching his pressure gage, his thermometer, and he's listening for that safety valve to pop indicating abnormal pressure.

In all these cases, the people concerned with the operation and others in the area are adequately advised of the hazards involved through visual signals employing color for classification of hazards, numerals for degree of hazard and positioning for instant recognition.

Experience Indicates Value

There's some experience with this hazard signal system in plant operation. Complete effect on people involved isn't definitely known; however, this system has been in use in several plants for more than two years.

First of all, people exposed to the system are curious. They want to know what the signal means. When they find out, they're definitely impressed.

There's every indication that hazard awareness increases. This is indeed a good vehicle to introduce a training program. It causes people to think.

It's a very good vehicle to develop safety consciousness. It promotes responsibility for operating and handling hazardous materials and for following instructions on their processing, storing and handling. It definitely assists the fire services in saving lives and reducing destruction of property.

It's also a good method for causing design engineers to think several times about the properties of materials handled in processes they are originating and designing.

There are instances where disasters were avoided because a hazard was recognized. This signal did cause people to think and act spontaneously in a safe manner.

Experience indicates it removes some of the vagueness from hazards. People talk more specifically now about the mysteries of chemicals and other hazardous materials. They talk about specific hazards inherent in a certain material without regard for the name. Fear of a hidden hazard is replaced with respect.

JAMES J. DUGGAN *has been with Union Carbide Chemicals Co. for the last 35 years. In that time he has worked in construction, operation and maintenance. For the past 24 years, Jim has devoted all his energy to fire protection, fire protection engineering and fire research. For the past four years, Duggan has had company-wide direction of safety and fire protection.*

*Classification of these chemicals is for illustration only. Each reader should satisfy himself by making his own tests to determine suitability for particular use.

The Fluid Energy

JET-O-MIZER

Grinds more products to finer particle size with greater uniformity

Superior products that command premium prices are produced in the "Jet-o-mizer"—the mill that grinds to the narrowest classification over the broadest range of particle sizes—that produces the highest product uniformity—and at a cost that will surprise you.

We invite you to see what the "Jet-o-mizer" can accomplish for your product, and to compare the results with ANY OTHER FINE GRINDING METHOD!

- Produces particles as low as ¼ micron average —or "coarse grinds" to −200 mesh—or to any in-between size.
- Grinds with NO oversize and MINIMUM undersize at the "coarse" end—or, can produce better than 99% below 3 microns!
- Operates continuously, for any particle size—with no rehandling.
- Insures unsurpassed product uniformity by maintaining perfectly duplicated processing conditions —no batch blending.
- Adjusts for optimum grinding conditions—maximum flexibility—greatest range of products.
- Accomplishes other physical or chemical operations while grinding—oxidation, reduction, coating, dehydration . . .
- Protects product purity—NO pickup of metal with ordinary materials—negligible contamination with abrasive materials especially with the use of newly developed ceramic and alloy liners.
- Available in laboratory sizes and production models to 8000# /hr.
- High product recovery with patented Jet-o-clone collectors.

Jet principle grinds with air or steam as grinding fluid—no moving parts—no heat from grinding—low maintenance.

Investigate our record of success in grinding chemicals, pigments, minerals, metals, ceramics, drugs, foods, plastics, abrasives, carbonaceous materials, insecticides, and many others.

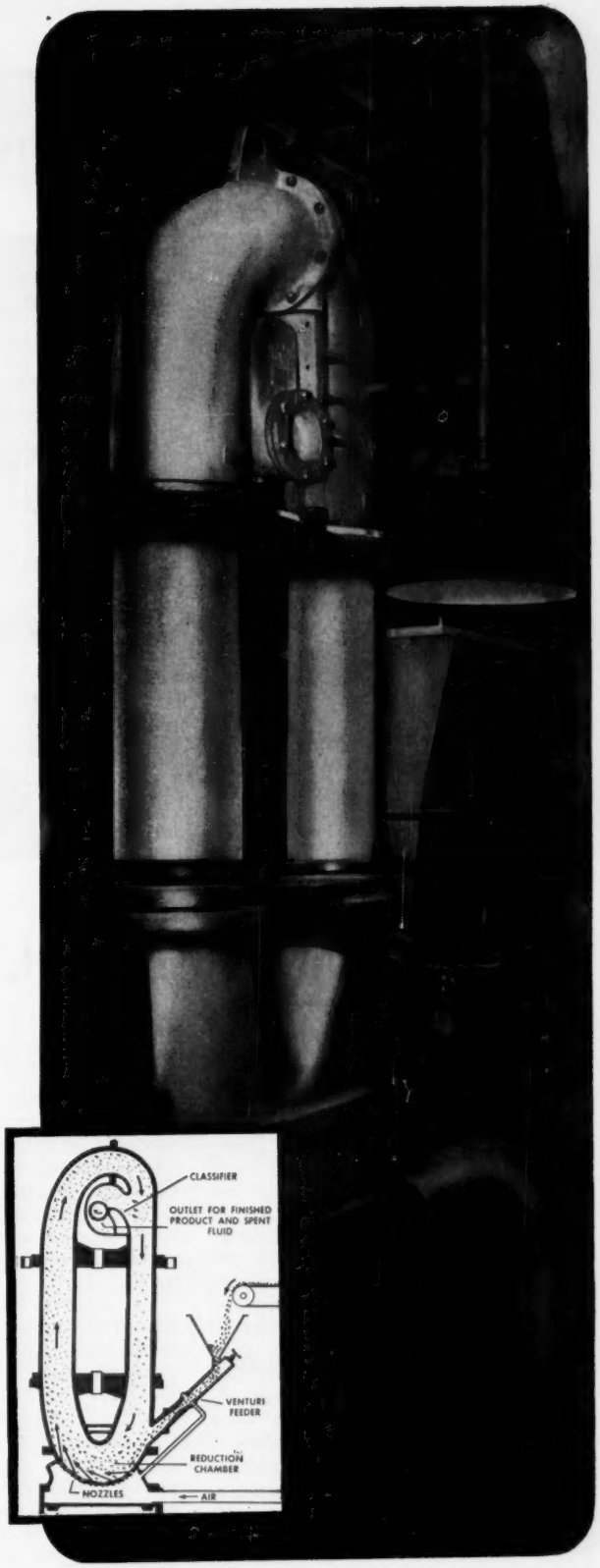
Investigate our facilities for product testing and custom grinding.

Investigate the *extra profit* possible with "Jet-o-mizing"!

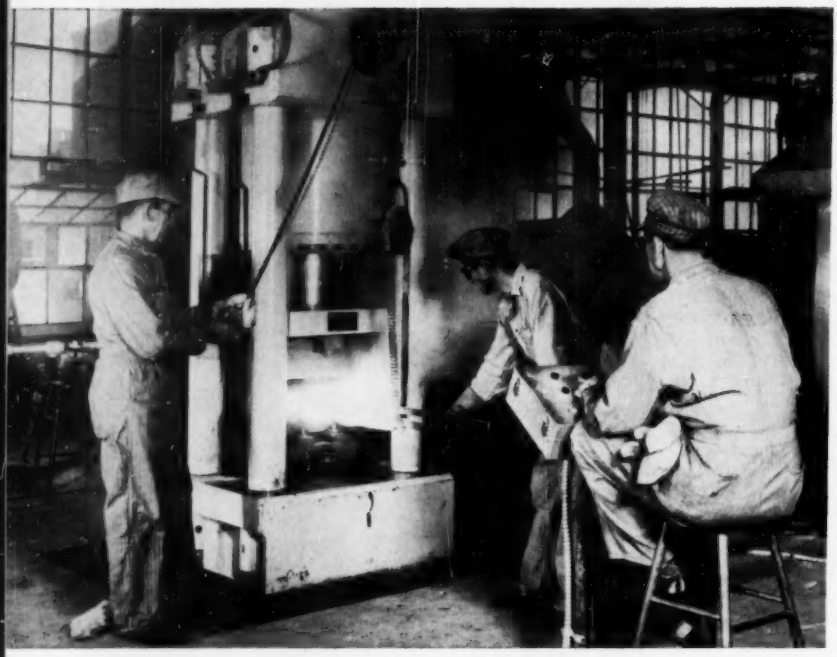
Send for our new bulletin describing "Jet-o-mizers" and "Jet-o-clones."

FLUID ENERGY
PROCESSING & EQUIPMENT COMPANY

Richmond & Norris Sts., Philadelphia 25, Pa.
(Formerly known as the Wheeler-Stephanoff Mill)



This is one of a battery of fourteen Fluid Energy Mills in the plant of a large talc producer in operation continuously for ten years.



To meet new, demanding high-temperature and nuclear processing requirements, alloy developers have come up with three radically-different metals.

3 New Alloys Beat Heat, Nuclear Barriers

The drive to higher and higher operating temperatures, and the heavy emphasis on nuclear designs, have profoundly influenced alloy producers. They must be constantly on their toes to develop new and better materials of construction.

How well they are meeting this situation was evidenced by the recent development of three new alloys—two for high-temperature service, one designed for nuclear applications.

What are these new materials, and why are they improvements? To answer these questions, let's examine each alloy separately.

Stainless Alloy: Ups Temperature to 1,600 F.

To fulfill a need for a "strong, hard, erosion-, oxidation- and corrosion-resistant material for service at 900-1,600 F.," Armco has developed a new stainless steel, called Armco 22-4-9.

It's big advantage is extreme hardness at room and elevated temperatures. It will not wear, gall or seize—ideal properties for valve stems, cladding of carbon-steel process components, and surfacing on shafts and rotating parts.

To achieve these properties, Armco has come up with an unusual composition (see table). Their alloy has a low nickel content (3-5%), high chromium (20-23%), high manganese (7-10%) and very high carbon (0.45-0.60%). It remains completely austenitic under all temperature conditions.

▶**High Carbon Content**—Most of the usual stainless steels recommended for high-temperature service have low-carbon contents. The 18-8 stainless series and types 309 and 310, usually have carbon contents of less than 0.20%.

The high carbon content of Armco 22-4-9 shows up in Brinnell hardness tests. At room temperature it has a Brinnell of 300-550, depending on processing methods. It holds this hardness at high temperatures —the material, with an initial room temperature hardness of 343 in one test showed a hot hardness of 250 after being at 1,100 F. for 1,000 hr. Compare this to Type 309, with a Brinnell hardness of 180 at room temperature.

High chromium content of this new stainless contributes to high-temperature strength. Stress to produce rupture in 1,000 hr. at 1,100 F. is 50,000 psi.—at 1,400 F. it's 10,000 psi.

a great new idea!! by Duriron for series **H Durcopump** users.

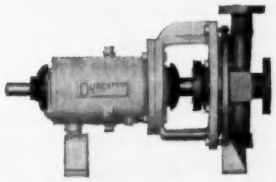
This is a happy engineer...He has developed the perfect bearing seal with chemically inert Teflon®. Positively nothing gets in...nothing gets out

This is a happy Durco sales manager. He is giving every series H. Durcopump user another plus feature that will increase bearing life and improve pump performance.

And this is you, the happy Durcopump user! You have the advantage of this latest Durco dividend, and at no extra cost. This perfect bearing seal keeps all contaminants out of the bearings, and all lubricants in. Another standard at Durco that is unavailable elsewhere.

DURCO
CORROSION RESISTING ALLOYS & EQUIPMENT

The mark of dependability in tough chemical service everywhere.



THE DURIRON COMPANY, INC. / DAYTON, OHIO

BRANCH OFFICES: Baltimore, Boston, Buffalo, Chicago, Cleveland, Dayton, Detroit, Houston, Knoxville, Los Angeles, New York, Pensacola, Philadelphia, Pittsburgh, and St. Louis

Important Components of New Stainless

Carbon	0.45–0.60%	Silicon	1.00% max.
Manganese	7.00–10.00%	Chromium	20.00–23.00%
Phosphorus	0.045% max.	Nickel	3.00–5.00%
Sulfur	0.12% max.	Nitrogen	0.30–0.50%

This compares favorably with usual stainless steels for heat service.

▶ **Intergranular Attack**—Plainly, because of the high carbon content, this new stainless is susceptible to severe intergranular attack by corrosive solutions. Armco's heat treatment involves solution and aging (2,150 F., then water quench plus 1,400 F., then air cool). The microstructure shows a finely dispersed intergranular and intragranular carbide precipitate within an austenitic matrix.

This is not a very serious problem at the temperatures for which the new alloy is designed (900-1,600 F.). Intergranular attack takes place only in the presence of an electrolyte; and at 900-1,000 F. the process material will probably be a gas. Nevertheless, caution will have to be used when shutting down equipment constructed of such an alloy, since condensed material can be a definite problem.

In high-temperature service, destructive scaling of 22-4-9 occurs above 1,600 F. This, then, is the safe maximum working temperature in an air atmosphere.

▶ **Easy to Weld**—Armco claims their material is easily welded, using any of the methods for stainless steel. Because of its austenitic structure, it can be welded without preheating or postheating, and is not susceptible to cracking.

Successful experience includes electrical flash-butt welding and oxacetylene or inert-gas shielded-arc welding processes.

As for machining, it's best done with carbide-tipped tools. Cutting is accomplished with lubricated abrasive disks or by hot shearing.

Nuclear Alloy: No Radioactivity Remains

A new series of carbon steels, designed primarily for nuclear applications, is offered by Jones & Laughlin Steel Corp.

J & L claims their materials are a "radical departure from standard steels."

They have one big advantage: they don't retain radioactivity. Thus equipment made from these steels can be repaired or maintained without a long cooling-off period.

Standard steels contain manganese and cobalt. Both become radioactive when bombarded by thermal neutrons and retain this radioactivity for long periods.

▶ **Low Mn, Co**—So J & L metallurgists have come up with compositions having very low percentages of manganese and cobalt. Other elements, such as titanium, have been added to improve mechanical properties.

Another big advantage for the new steels: they have excellent cold-forming characteristics. A hot formed seamless tube of 2⅜-in. O.D. was easily reduced to ¾-in. O.D. by cold drawing.

J & L says these low-manganese nuclear alloys can be produced in plate, sheet, strip, bars, tubing, rods, wire and extruded shapes. And they can be welded and fabricated by conventional methods used for most carbon steels.

Nominal composition of J & L's new material is as follows: 0.10% Mn, 0.20% Si, 0.20% Ti, 0.10% Al, 0.20% C.

Lightweight Alloy: Poor Man's High-Temperature Metal

Word comes from the National Research Corp. of a new group of iron-aluminum-manganese alloys which combine light weight, excellent ductility, high-temperature strength and oxidation resistance.

Calling this the "poor man's" high-temperature alloy family —no chromium or nickel is used—NRC considers their work an important technological breakthrough in the production of low-cost high-temperature alloys.

The composition of the most promising material is: 10% Al; 34.4% Mn; 0.76% C; balance iron.

▶ **Ductility Improved**—No name has been coined for this group as yet, but it is related to the Alfenol and Thermenol alloys. Alfenols are iron-aluminum compositions; Thermonols are iron - aluminum - molybdenum. Both groups have excellent high-temperature properties, but are not very ductile at room temperature. NRC metallurgists added manganese to iron-aluminum and came up with a group

New Stainless Holds Strength at High Temperatures

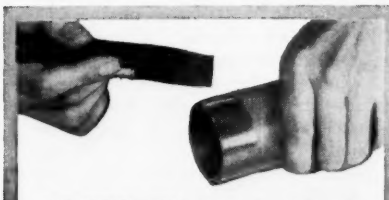
	Room	900 F.	1,100 F.
After 1,000 hr. at 900 F			
Ultimate tensile strength, psi. (1,000)	162	115	98
0.2% yield strength, psi. (1,000)	106	64	51
Elongation, % in 2 in.	8.0	16.0	19.0
Reduction of area, %	8.0	17.0	23.0
Brinell hardness	343	250	250
After 1,000 hr. at 1,100 F			
Ultimate tensile strength, psi. (1,000)	160	.....	96
0.2% yield strength, psi. (1,000)	108	.....	50
Elongation, % in. 2 in.	8.0	.....	17.0
Reduction of area, %	7.0	.....	22.0
Brinell hardness	343	.....	250

USCOLITE PLASTIC PIPE

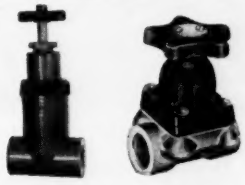
PIPE DREAMS come true!

Mr. Usco introduces the complete family of pipe, valves and fittings!

USCOLITE® plastic pipe comes in two specific types, each equally good for its particular purpose. Uscolite CP for high impact resistance, Uscolite RV (PVC) for active oxidizing agents. Not one foot of pipe has had to be replaced in the 10 years since first installed.



USCOWELD* Fittings are the only solvent-weld fittings with an interference fit. Greater joint strength, faster insertion. Non-porous, leak-proof. Made of either Uscolite CP or RV materials.



USCO® VALVES offer a choice of either Hills-McCanna diaphragm valve or Vanton "Flex-Plug" gate valve.

USCOFLOW is a new, black utility pipe, especially suited where low first costs are a factor. It is a blend of styrene-base resin and synthetic rubber for good impact resistance and high tensile strength.

The "Usco" Plastic Pipe Line of precision-molded pipe and fittings for every corrosion and flow problem includes elbows, tees, couplings, flanges, reducing bushings, plugs, caps, nipples, bends.

When you think of plastic, think of your "U.S." Distributor. He's your best on-the-spot source of technical aid, quick delivery and quality plastic pipe and fittings.

Mechanical Goods Division

*Patent applied for

United States Rubber

WORLD'S LARGEST MANUFACTURER OF INDUSTRIAL RUBBER PRODUCTS

Rockefeller Center, New York 20, N.Y. In Canada: Dominion Rubber Company, Ltd.

which can be easily cold-worked at room temperature.

Also, previous iron-aluminum alloys rapidly lose strength above 1,200F. One new NRC austenitic alloy has a tensile strength of about 110,000 psi. at room temperature; at 1,200 F. it's 60,500 psi.

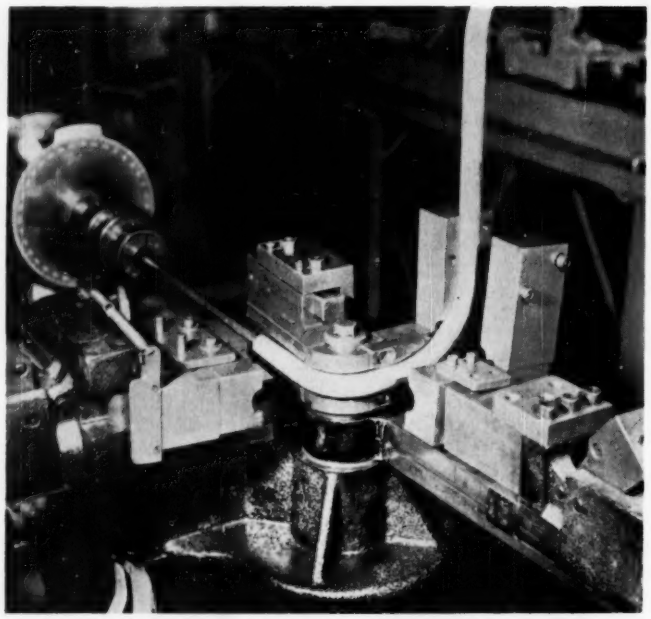
▶ **Low Density**—This strength, combined with low density, make for strength-to-weight ratios higher than most alloys used in high-temperature service. Density of these new alloys average about 6.6 grams/cc. Compare this against 18-8 stainless with a density of 7.93, cobalt-based alloys with a density of around 8.6, and Hastelloy alloy B with a value of 9.24.

Of particular interest is oxidation resistance. NRC has run tests on a number of materials. Small 0.125-in. thick wafers were used as specimens. The depth of oxide penetration for one of their better new alloys was 0.0065 in. at 1,500F. (100 hr.); 0.014 at 2,200F. (46.5 hr.). This can be called adequate, although Type 310 stainless and Udimet 500 have a penetration of 0.005 in. at 1,500F.; 0.0025 at 2,200F. Other alloys in the NRC group show very low rates of penetration, but with some sacrifice of mechanical properties.

NRC says cold working properties of the iron-aluminum-manganese alloys approximate those of 18-8 stainless. Thus, they can be formed by bending, rolling, swaging, stamping.

Another important point: strain aging by heat treatment, following cold working, gives even higher strengths after products are formed. Austenitic steels of the chrominum-nickel type normally soften, lose strength if heated after cold working. By this technique, the new alloys can possibly have tensile strengths as high as 250,000 psi.

NRC tells us this new family is not commercially available at this time. The research and development work was performed in connection with a Navy contract.



Titanium Tubing With Sharp Bends Now Possible

Titanium tubing can be easily bent now on a radius as small as its own diameter. Such a sharp bend was considered impossible just a short time ago.

This development should boost the use of titanium tubing, particularly in equipment which must be compact and light.

Ordinarily titanium doesn't bend as easily as stainless steel —Ti's yield strength is much greater and it's less ductile. But Kreisler Industrial Corp., Paterson, N. J., has come up with a technique of drawing the tubing around a rotating bending form. It's held in position by special moving clamps, dies and mandrels. The procedure works best on the soft, A-40, grade of titanium. As an example of what can be done: 0.750-in. O.D., 0.035-in. wall, tubing has been bent to a 90 deg. angle on a 0.750-in. radius.

New Aluminum Pipe Heavy at Ends

Heavy-end aluminum pipe promises big cost savings in process plant construction. The pipe is produced by a new extrusion process, developed by Reynolds Metals.

Putting metal where it's needed for strength—at the ends where welded or threaded joints are made—Reynolds eliminates excess thickness in the pipe body. For operating pressures equivalent to standard pipe, cost savings can be as high as 27%.

It's presently available in sizes equivalent to many standard Schedule 40 and 80 sizes. But the extrusion process is flexible and capable of producing a wide range of pipe diameters and wall thicknesses.

Superior Oil Co. will make first operational use of the new pipe at Lake Maracaibo, Venezuela. Superior has ordered 8,000 ft. of 6-in. pipe, with working pressures equivalent to Schedule 80. Made of alloy 6061-T6, the material will be used in an underwater flow line system.

STRONG as steel pipe

...at one-eighth the weight!

Circumferential Tensile Strength... 80,000 psi

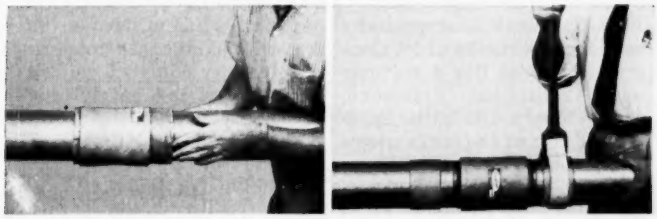
BONDSTRAND®

the revolutionary fiber glass reinforced epoxy pipe for corrosive service

114

Here's a pipe that holds up indefinitely under the corrosive action of many salt, acid and alkaline solutions... that can't contaminate or flavor the piped material... that is rigid enough to resist sag, cold flow or deformation – flexible enough to follow normal ditch contours... that remains smooth and unclogged throughout its entire service life... that won't leak, even near its burst pressure.

Easy to install, with choice of locking wedge or threaded fittings.



Simple instructions with each shipment insure a perfect joint on the first try.

IN THE CHEMICAL INDUSTRY...

This means that you can use BONDSTRAND to transport corrosive solutions, waste water, sewage, oils, foods, beverages and many other troublesome fluids. It's also ideal for ducting, conduit or handrails where corrosive atmospheres, condensation, spillage or immersion cause troubles with ordinary pipe.

Amercoat® CORPORATION

Dept. AB • 4809 Firestone Boulevard • South Gate, California

921 Pitner Avenue, Evanston, Illinois
360 Carnegie Avenue, Kenilworth, New Jersey
2404 Dennis Street, Jacksonville, Florida
6530 Supply Row, Houston, Texas

A Subsidiary of American Pipe & Construction Company

"He says he's using *Mallinckrodt chemicals* to avoid frequent adjustment of his process equipment."

Seriously speaking...

Precise purity levels in process chemicals are increasingly important to industry . . . to smooth out the process, improve product quality and reliability —and cut operating costs.

Mallinckrodt first earned its international reputation among laboratory chemists and pharmacists. Now, the major share of our business is in bulk chemicals supplied to more than 200 industries—in ton and carload lots, delivered with the same high standards of purity.

Next time you need precision-manufactured process chemicals of consistent purity and specific physical form—call Mallinckrodt.

Remember . . . you might be better served by Mallinckrodt

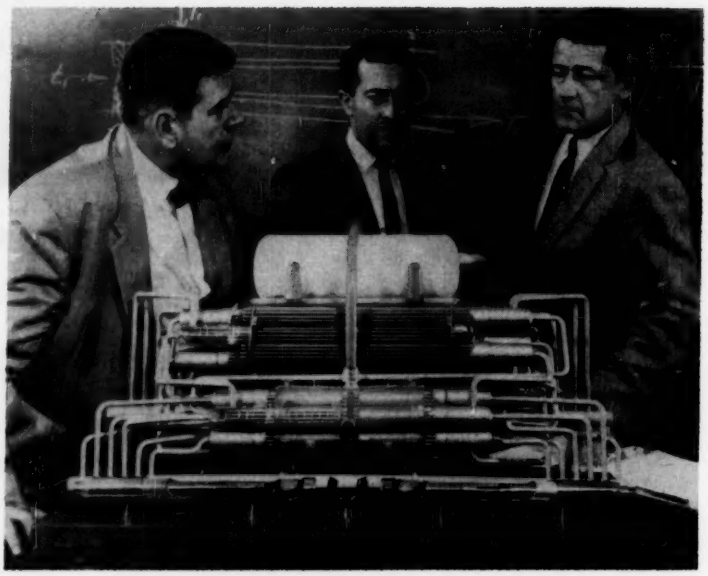
Mallinckrodt®

MALLINCKRODT CHEMICAL WORKS
ST. LOUIS · NEW YORK · MONTREAL

FIRMS IN THE NEWS

R. A. LABINE

NEW FACILITIES



Nuclear Steam Generator Gets the Once-Over

Engineers at the Griscom-Russell Co. examine a model of a liquid-metal-heated steam generator similar to the three units ordered from G-R by Atomics International for the Hallam, Neb., nuclear plant of Consumers' Public Power District. A test prototype has operated successfully for the past year.

Allied Chemical is reportedly starting expansion of its General Chemical Div.'s sulfuric acid facility at Richmond, Calif. New production capacity and cost of the project have not yet been revealed.

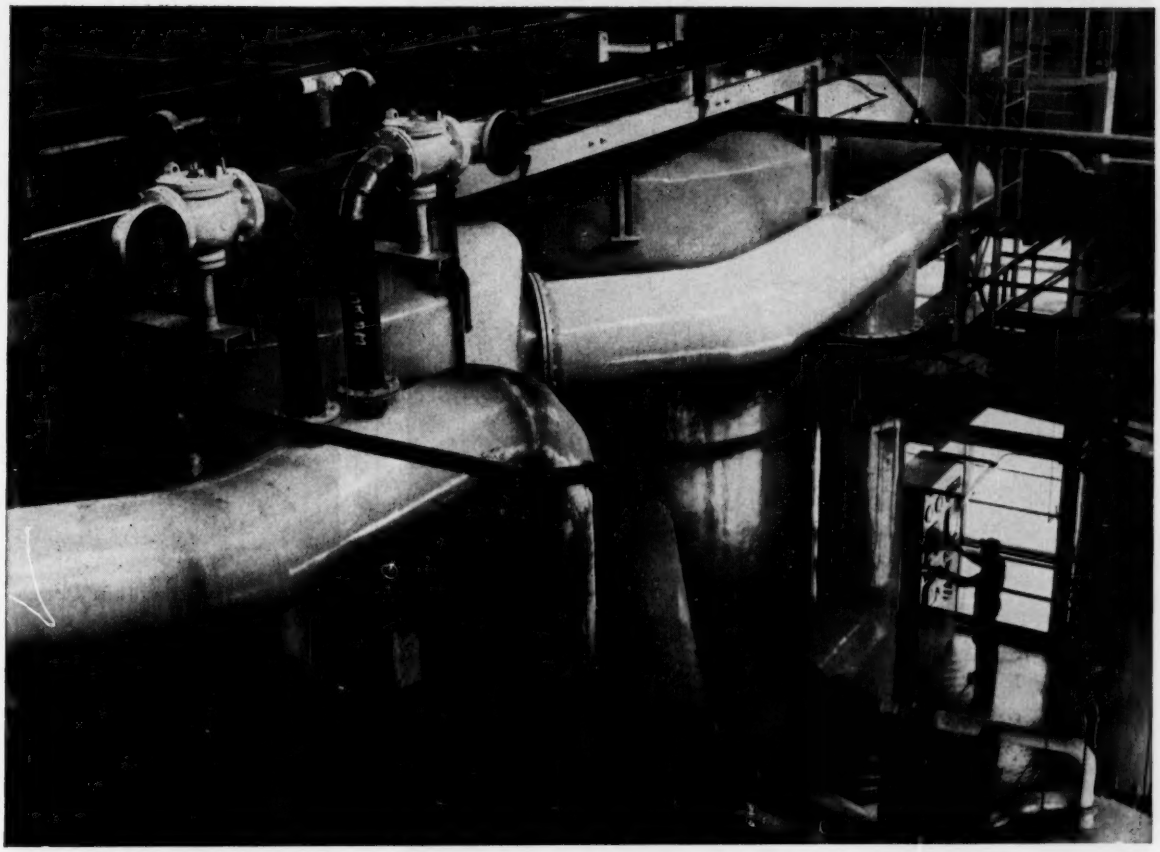
National Starch Products plans a 50% expansion of its vinyl acetate polymerization plant in Meredosia, Ill. Addition includes copolymer tanks and handling facilities, a new warehouse and reactor capacity of 4,000 gal.

Morningstar-Paisley has started production of liquid vinyl chloride at its new Clifton, N. J., plant. New plant includes 100,000 sq. ft. manufacturing space adjoining the firm's recently acquired Haberland starch facility.

Monsanto's British subsidiary, Monsanto Chemicals, Ltd., will erect a 15-million-lb./yr. maleic anhydride plant at Newport, Monmouthshire, Eng. Scientific Design Co. will handle the project on a turnkey contract using an SD process for catalytic vapor-phase air-oxidation of benzene.

Humble Oil plans to construct a 238-mi., 30-in. natural gas line from future site of King Range gas plant to its Clear Lake plant near Houston, Tex. Line, to be completed by 1960, will connect with the 78-mi. line from Clear Lake to Port Arthur.

Reichhold Chemicals has construction under way on a new $5-million, 30-million-lb./yr. phthalic anhydride plant at



Zaremba evaporator bodies, piping and other equipment of new chlorine-caustic soda plant at Hooker Chemicals, Ltd., North Vancouver, B. C., are made of Nickel to guard against corrosion, assure product purity. (Much of the equipment supplied by Puget Sound Fabricators, Inc., Seattle).

Nickel "bodyguards" protect new caustic plant

To prevent caustic corrosion . . .

To safeguard product purity . . .

These are the principal reasons why Inco Nickel and Monel* nickel-copper alloy are used in the new chlorine-caustic soda plant of Hooker Chemicals Limited.

Equipment made of corrosion-resisting Inco Nickel and its alloys frequently gives more than a decade of service in handling strong caustic. Equally important, Nickel equipment has enabled producers to make millions of tons of caustic a year with less than 100 ppm of metallic impurities.

See how Nickel and Monel alloy are used in Hooker's new chlorine-caustic plant equipment

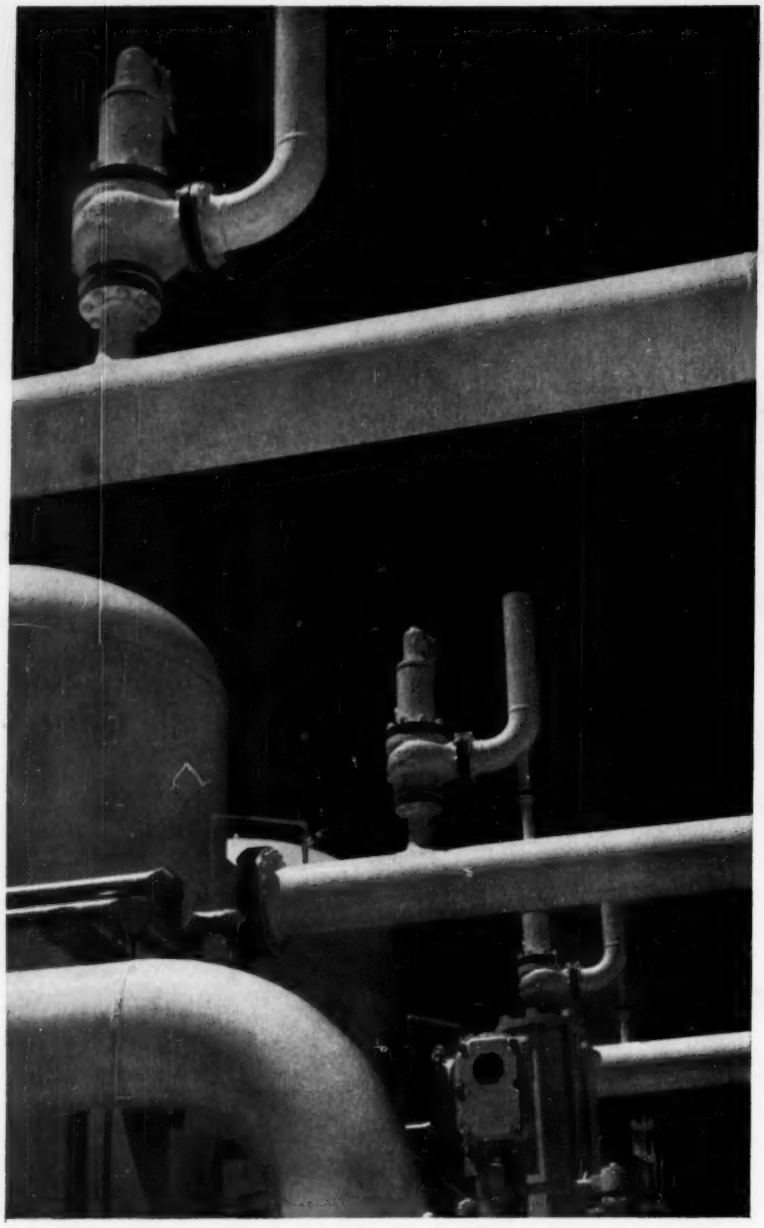
EQUIPMENT	MATERIAL	EQUIPMENT	MATERIAL
Caustic Tank	Nickel-clad steel	Salt receiver tanks	Nickel
Evaporator body	Nickel	Salt separator tanks	Nickel
Second effect vapor body	Nickel-clad steel	Barometric condenser	Monel alloy
Third effect vapor body	Nickel-clad steel	Cylinder coolers	Nickel-clad steel
		Cooling coils	Monel alloy tubing

It will pay you to specify equipment of Inco Nickel, Monel alloy or Nickel-clad steel. Inco Nickel Alloys can be obtained in most mill forms right from warehouse stocks. (Listed under "Nickel" in your classified directory.)

Get complete technical data and service records. Write for "The Resistance of Nickel and Its Alloys to Caustic Alkalies." *Registered trademark

The INTERNATIONAL NICKEL COMPANY, Inc.
67 Wall Street New York 5, N. Y.

INCO NICKEL ALLOYS



Crosby Safety-Relief Valves on inlet scrubbers to gas booster station — El Paso Natural Gas Co., New Chaco Station, San Juan Co., N. M.

Where there's no compromise with safety...
you need the absolute reliability of
Crosby Safety-Relief Valves

CROSBY VALVE AND GAGE CO.
Wrentham, Massachusetts
Offices in Boston, New York, Chicago, Los Angeles, Dallas, London, Paris.

Crosby
KEEPS PRESSURE ON THE SAFE SIDE

- Safety Valves for power boiler code requirements
- Safety-Relief Valves for unfired pressure vessel code requirements
- Pressure Indicating and Recording Gages
- Pressure Testing Instruments

FIRMS . . .

Elizabeth, N. J. Badger Mfg. Co. is handling construction.

Baldwin-Lima-Hamilton Corp.'s Standard Steel Works has installed a 30,000-lb. capacity electric melting furnace as part of a modernization program at its Burnham, Pa., plant. Furnace makes possible the production of high-alloy steels which B-L-H bought in the past.

Oil Sands, Ltd., and L. R. Champion are considering building a 20,000-bbl./day tar sands processing plant within a year in Canada's Athabasca tar sands region. Oil from sands is expected to run about 30 gravity, and would be extracted by hot-water process. Plans include a pipeline to Edmonton where crude would be further refined.

Sun Oil's Toledo, Ohio, refinery has just installed a $150,000 sulfur recovery unit that produces molten sulfur from H_2S produced in refinery operations; recovery capacity is 12.5 long tons/day sulfur.

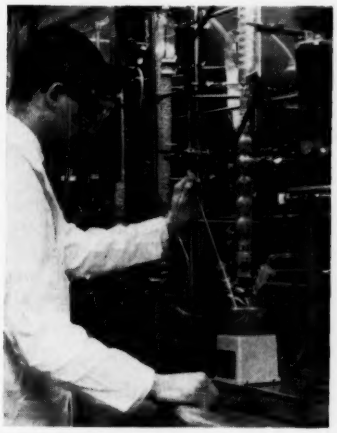
U. S. Industrial Chemicals' polyethylene plant near Houston, Tex., is nearly complete. Initial capacity will be 75 million lb./yr.; M. W. Kellogg is the general contractor.

Linde is building a new 94-million-cu.ft./mo. oxygen plant for U. S. Steel's Gary Steel Works at Gary, Ind., doubling oxygen output at the plant. In addition, new unit will produce 256 million cu. ft./mo.

high-purity dry nitrogen used to form an inert atmosphere over steel sheets during annealing operations.

Monsanto has completed expansion of its chlorosulfonic acid facilities at Monsanto, Ill. Cost and capacity of the expansion were not announced.

Crown Zellerbach Corp. is building a $110,000 chemical products pilot plant at Camas, Wash. Building, to be completed in March, will provide facilities for developing new processes to utilize lignins, wood sugars and other leftovers from papermaking.



Du Pont's Electrochemicals Dept. has formally opened its new research center at Niagara Falls, N. Y. Building, housing about 100 persons, will be the focal point for research and development on products and processes related to firm's business in sodium, vinyl products, peroxygen compounds, nylon intermediates and related fields.

Southern Chemical Cotton Co. is planning to construct a building adjacent to its present Chattanooga, Tenn., plant. New building, scheduled for completion late this year, will have a daily production capacity of 30,000 lb. of industrial filtering paper.

Bell Chemical Co., Reading, Pa., maker of dyes for synthetic materials, is expected to build

Another packaging advance by Continental

the new

HI-STACKER

utility can with reversible spout

- *Saves time, space, filling and shipping costs*
- *Simple to palletize*
- *I.C.C. approved*

Continental's new, Dome-top Hi-Stacker makes every inch of shipping, storage and display space count. It's easy to fill, easy to handle. Filler openings are available to fit your requirements. For further details, ask your Continental man.

REVERSIBLE SPOUT RIDES SAFELY, ATTACHES EASILY

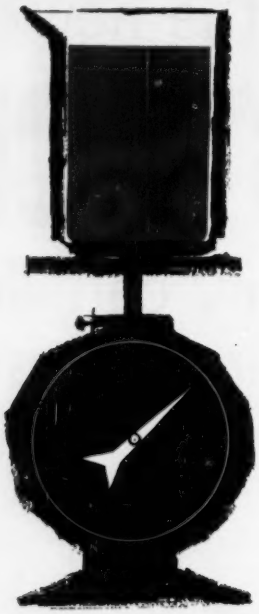
Spout remains inverted during shipment and storage. To pour, spout is reversed – ready for fast, smooth dispensing. Spout remains in fixed position until container is empty.

Looks like Continental's famous Dome-top utility can (at left). Has all its sales features. Completely redesigned to save space and money.

CONTINENTAL CAN COMPANY

Eastern Div.: 100 E. 42nd St., New York 17
Central Div.: 135 So. La Salle St, Chicago 3
Pacific Div.: Russ Building, San Francisco 4
Canadian Div.: 5595 Pare St., Montreal, Que.

more pounds per gallon

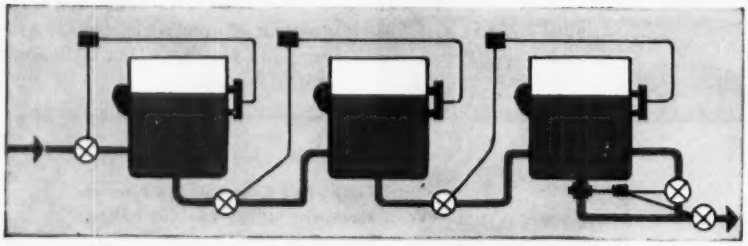


AccuRay MULTI-EFFECT EVAPORATOR CONTROL SYSTEM

Only an AccuRay Continuous Process Analyzer and Level Control System senses density and level independent of other product characteristics. More pounds per gallon are obtained by minimizing process variable spread. The AccuRay Process Analyzer, external to the process, continuously measures total solids in both solutions and slurries to accuracies of ±.001 specific gravity. The AccuRay Level Control System maintains liquid level to ±⅛ of an inch.

In the diagram of a forward feed evaporator system shown below, a level control system on the exterior wall of each evaporator maintains constant solution level. The Density Control System on the last effect maintains crystallized product at the highest possible pounds per gallon, with minimum fuel cost.

Let Accuray work for you . . . write today for complete information



Industrial Nucleonics
CORPORATION

1149 Chesapeake Ave. • Columbus 12, Ohio

The WORLD'S LARGEST Manufacturer of Nucleonic Industrial Process Control Systems

FIRMS . . .

a new plant in Chester, Pa. Firm's Reading, Pa., plant burned recently with an estimated loss of $400,000.

Union Oil Co. of California has just purchased 1,100 acres of land in the Everett, Wash., area, reportedly completing land acquisitions required for a new refinery. Union is the third major oil company to purchase land in the area for refinery sites, others being Richfield and Standard of California. Union and Stancal indicate they have no building plans before 1960.

Stauffer Chemical Co. has purchased from Mallory-Sharon Metals Corp. the one-third interest which the latter firm held in the Temescal electron-beam furnace development. Joint venture will now be known as Stauffer-Temescal Co. with headquarters at Richmond, Calif.

Du Pont's International Dept. has been reorganized into two major geographical areas to streamline its activities. Director of European operations will be headquartered in London, Eng., while head of the Latin American Div. will be stationed in Wilmington, Del.

McGraw-Hill Book Co. has acquired the rights to five books formerly published by Handbook Publishers: Lange's "Handbook of Chemistry," "Handbook of Probability Statistics," "Handbook of Mathematical Tables & Formulas," "Pressure-Volume-Temperature Relationships of Organic Compounds," and "The Analytical Balance."

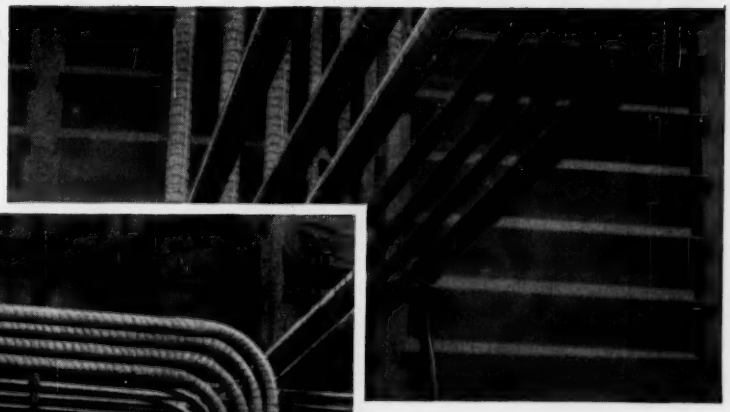
Gulf Oil Corp. has exercised an option to increase its interest in Callery Chemical to 50%. Last April, Callery opened its own $5-million HiCal high-energy fuel plant

THE MODERN TOOL... AT WORK FOR MODERN INDUSTRY

to stop corrosion

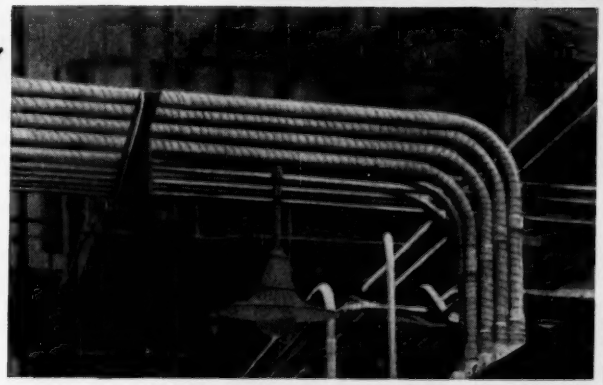
here

Polyken Protective Tape Coating is tough and long-lasting . . . that's why maintenance men prefer it to costly repainting.



or here

Polyken is polyethylene tape coating . . . elastic, inert, nondrying . . . offering stable protection under severe chemical conditions.



or here

Polyken's doubly thick adhesive system holds tight . . . seals voids . . . bonds to clean surfaces without a primer.

start here

(contact your local Polyken distributor)

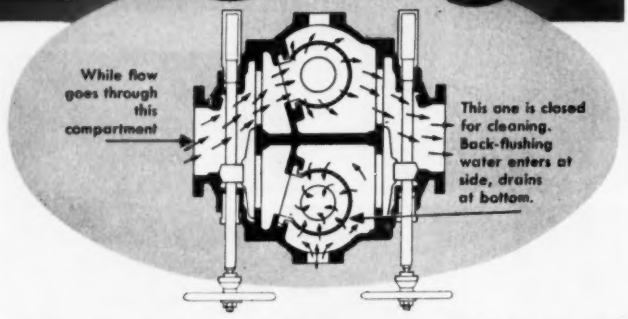
Atlanta, Georgia: Steele & Associates, Inc.
Chicago, Ill.: Sales Engineering, Inc.
Cincinnati, Ohio: Hare Equipment
Cleveland, Ohio: The Harco Corp.
Denver, Colo.: Patterson Supply Co.
Des Moines, Ia.: The Donald Corp.
Fort Worth, Texas: Plastic Engineering & Sales Corp.
Gretna, La.: Allen Cathodic Protection Co.
Houston, Texas: Cathodic Protection Service
Kansas City, Mo.: Industrial Coating's Engineering Co.
Long Beach, Calif.: Barnes & Delaney
Minneapolis, Minn.: Simcoe Equipment Co.
Philadelphia, Pa.: Harold N. Davis Co.
Pittsburgh, Pa.: Royston Laboratories, Inc.
Plainfield, New Jersey: Stuart Steel Protection Corp.
St. Louis, Mo.: Shutt Process Equipment Corp.
San Francisco, Calif.: Aetna Sales Co.
Seattle, Wash.: Farwest Corrosion Control Corp.
Seattle, Wash.: Pacific Water Works Supply Co.
Tulsa, Okla.: William Cluff Corp.

Polyken®

Experienced in modern PROTECTIVE COATING

THE KENDALL COMPANY
Polyken Sales Division

Twin Strainer with special back-flushing feature


While flow goes through this compartment
This one is closed for cleaning. Back-flushing water enters at side, drains at bottom.

Elliott Twin Strainers are built in two types. With Type A, one strainer basket is removed and dumped, while liquid flows through the other basket. Type A strainers are also built with a back-flushing feature, whereby the closed-off compartment is cleaned by reversing the liquid flow. Flushing and draining connections permit liquid to enter side of compartment, flow through basket and drain at bottom. Type V, with large-size baskets, is designed primarily for handling oil and viscous liquids.

For over 50 years, Elliott Strainers have been effectively removing objectionable solids from water and other liquids. The resulting trouble-free service has led to installations in power and industrial plants all over the country. Elliott also makes Single Strainers, one type having an Automatic Self-Cleaning feature, the other type with a removable basket for manual cleaning. For details call your Elliott District Office or write Elliott Company, Accessories Department, Jeannette, Pa.

A7-1

ELLIOTT Company

STEAM TURBINES • MOTORS • GENERATORS • DEAERATING HEATERS • EJECTORS • CONDENSERS • CENTRIFUGAL COMPRESSORS • TURBOCHARGERS • TUBE CLEANERS • STRAINERS

in Lawrence, Kan., followed by the opening last October of the $38-million HiCal plant at Muskogee, Okla., operated for the Navy.

Olin Mathieson has sold its 44% ownership of F. H. McGraw & Co., completing the firm's disposal of operations not related to its principal fields of activity.

Chas. L. Husking & Co., New York, N. Y., has purchased from Du Pont its patents and processes for production of medicinal and technical-grade synthetic camphor.

OVERSEAS BRIEFS

Hungary and Rumania have completed a 227-mi. natural gas pipeline linking the Rumanian gas wells at Buciumen with the new Hungarian industrial town of Tiszapalkonya. Eventual plan is to produce "synthetic raw materials" in a plant to be completed in 1963. Russia supplied 11,000 tons of pipe for the 84-mi. Hungarian section.

Britain's Gas Council has licensed three British companies to sell plants in England and abroad for the Council's process for hydrogenating gas and oil (*Chem. Eng.*, Aug. 25, 1958, pp. 64-68). Companies are Humphrey & Glasgow, Woodall-Duckham Construction Co., and Henry Balfour & Co.

Fertilizantes Sinteticos is starting up its $10-million petrochemical plant at Callao, Peru. Built under the technical supervision of Montecatini of Milan, Italy, plant's initial annual production capacity is 25,000 tons fertilizer-grade ammonium nitrate, 5,000 tons explosives-grade ammonium nitrate, 1,500 tons 98% nitric acid, 15,000 tons ammonium sulfate, 1,000 tons anhydrous ammonia.

CALENDAR

Technical Assn. of the Pulp and Paper Industry-American Paper and Pulp Assn., research symposium, Waldorf Astoria Hotel.
Feb. 26 New York, N. Y.

American Institute of Chemical Engineers-American Chemical Society, joint technical conference, Lamar State College of Technology.
March 13 Beaumont, Texas

American Institute of Chemical Engineers, national meeting, Chalfonte-Haddon Hall Hotel.
March 15-18 Atlantic City, N. J.

American Society of Mechanical Engineers, annual spring conference of Lubrication Div., Franklin Institute.
March 16-17 Philadelphia, Pa.

National Assn. of Corrosion Engineers, annual meeting and exhibition, Sherman Hotel.
March 16-20 Chicago, Ill.

American Society for Metals, 11th Western Metals Exposition and Congress, Pan-Pacific Auditorium and Ambassador Hotel.
March 16-20 Los Angeles, Calif.

American Society of Mechanical Engineers, Instruments and Regulators Division Conference, Case Institute of Technology.
March 29-April 2 Cleveland, Ohio

American Institute of Chemical Engineers, Philadelphia-Wilmington Sections, Symposium: Experience in Industry, University of Pennsylvania.
March 31 Philadelphia, Pa.

American Institute of Mining, Metallurgical and Petroleum Engineers, Technical Conference: Stress Corrosion Mellon Institute.
April 2-3 Pittsburgh, Pa.

American Chemical Society, annual national meeting.
April 5-10 Boston, Mass.

Nuclear Congress, coordinated by the Engineers Joint Council, Public Auditorium.
April 5-10 Cleveland, Ohio

Instrument Society of America, Second National Symposium on Chemical and Petroleum Instrumentation.
April 6-7 St. Louis, Mo.

American Institute of Mining, Metallurgical and Petroleum Engineers, 42nd national Open Hearth Steel Conference and Raw Material Conference, Jefferson Hotel.
April 6-8 St. Louis, Mo.

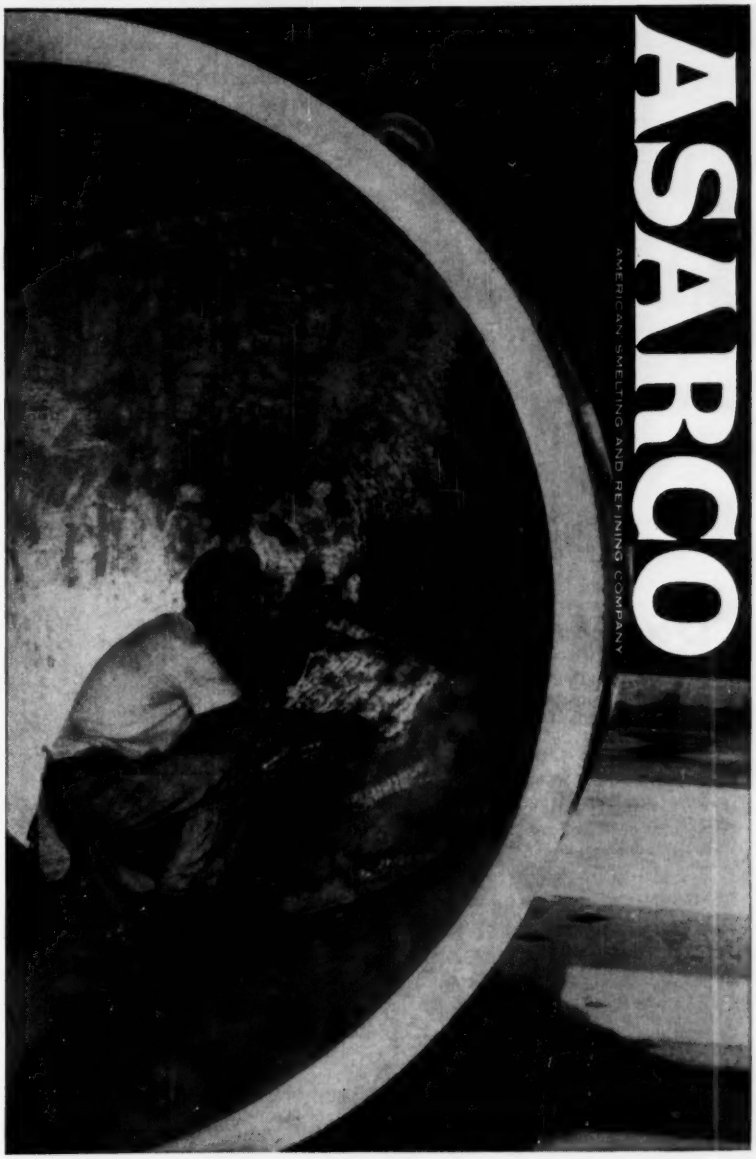
American Institute of Chemical Engineers, Ohio, Pittsburgh and West Virginia Sections, annual symposium: Catalysis, Mellon Institute.
April 10 Pittsburgh, Pa.

Engineering, Marine Welding and Nuclear Energy Exhibition.
April 16-30 Olympia, England

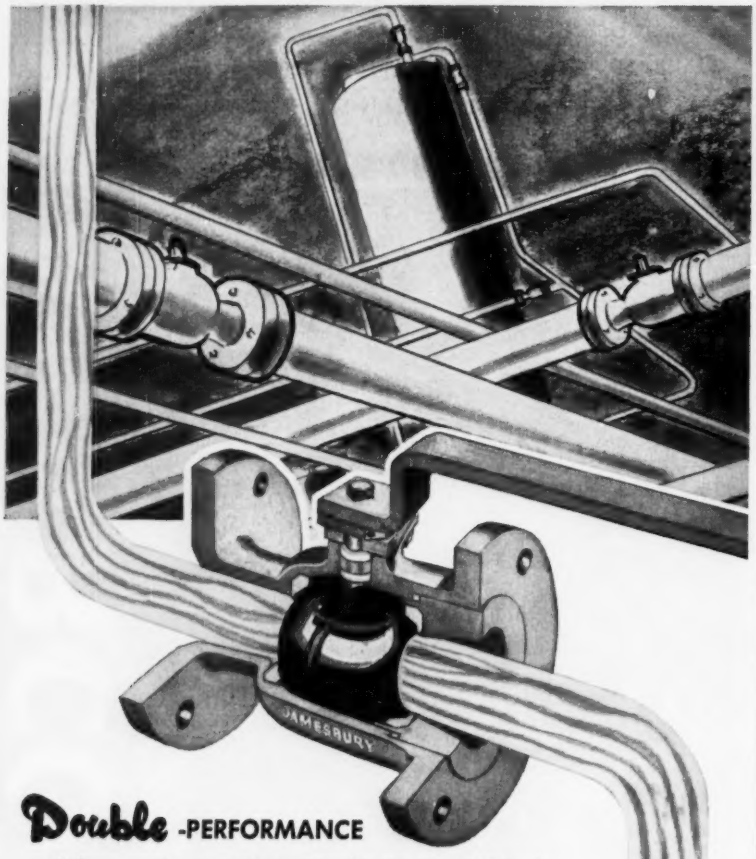
American Oil Chemists Society, 50th Anniversary Meeting Roosevelt Hotel.
April 20-22 New Orleans, La.

Federated Lead Fights Corrosion! **Federated lead is one of the most efficient and economical protection materials against many acids. Lead is self-healing. Scratch it and a protective coating re-forms immediately. Lead is easy to work and moderately priced. Federated produces chemical lead in sheets to your requirements. Pipe, bends, traps and standard fittings available from stock. Special forms fabricated to order. Call the Federated Sales Office near you. Or write for Bulletin No. 162, the Lead Handbook for the Chemical Process Industries. Federated Metals Division, 120 Broadway, New York 5. In Canada: Federated Metals Canada, Ltd., Toronto and Montreal.**

FEDERATED METALS DIVISION OF



Jamesbury "Double-Seal" Ball Valves Give Double-Value



Double-PERFORMANCE

Wherever the Jamesbury "Double-Seal" principle is employed in its multiple industrial applications, "Superior performance" is the phrase heard everywhere.

PERFORMANCE — the direct result of the high-efficiency and the long, maintenance free life of the Jamesbury product: "Double-Seal" Ball Valves.

Ball Valves in pipe sizes ¼" to 8" in Bronze, Aluminum, Stainless Steel, Carbon Steel and PVC. Quarter-turn.

Distributors In Principal Cities.
Get The Complete Facts On The Jamesbury "Ball Valve" Principle.

Name..... Title.....

Company.....

Address.....

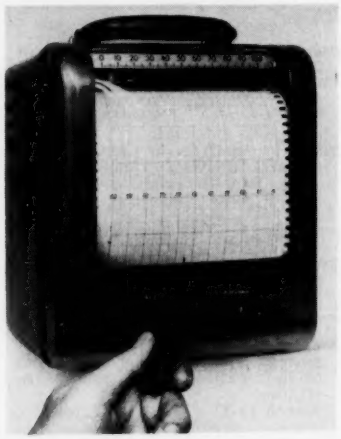
City..... State.....

☐ Jamesbury Literature
☐ Distributor Service

JAMESBURY CORP., 75 NEW STREET, WORCESTER, MASS.

NEW EQUIPMENT . . .

(*Continued from p. 92*)

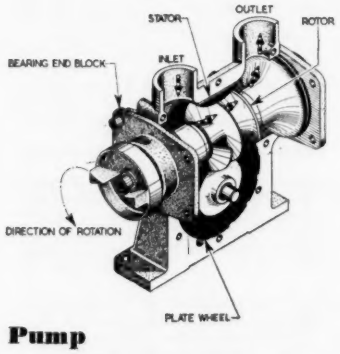


Temperature Recorder

Portable unit also mounts in racks or panels.

Plug-in elements, each of which matches a corresponding thermocouple, provide a new, portable, 5-in. strip-chart recorder with a wide variety of operating ranges. Typical spans are −150 to 250 F., 0 to 400 F. and 0 to 2,200 F.

Another feature is automatic reference-junction compensation—no external temperature reference is needed. Limit of instrument error is 1% of span. Chart paper comes with either Fahrenheit or Centigrade calibrations. — **Varian Instrument Div., Palo Alto, Calif. 182A**



Pump

British-made unit claims revolutionary design.

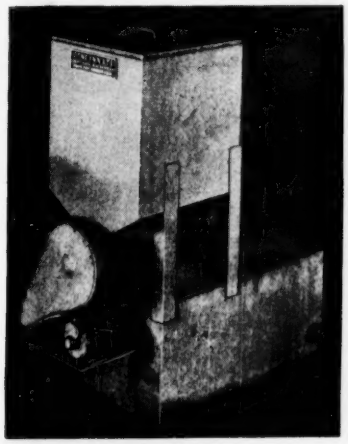
In early 1958, a new all-purpose industrial pump made its debut in Britain. According to reports, this positive-displace-

ment unit was very well received; it is now being offered to U. S. industry.

Inherently self-priming, the pump provides suction lifts up to 30 ft. at speeds between 750 and 3,000 rpm. Capacity is claimed to be constant at any given speed against pressures from 0 to 100 psi.

Only two moving parts contact the liquid—the metal rotor and a rubber-bonded plate wheel. Motion of the screw-type rotor between the plate wheel and a rubber stator forms an advancing cavity that assures positive liquid displacement.

Welcome characteristics include positive axial flow, pulseless action and high efficiency. Permutations of the four body materials, three rotor materials and four elastomers can satisfy a major portion of possible applications. — **Goodyear Pumps, Inc., N. Y., N. Y. 182B**

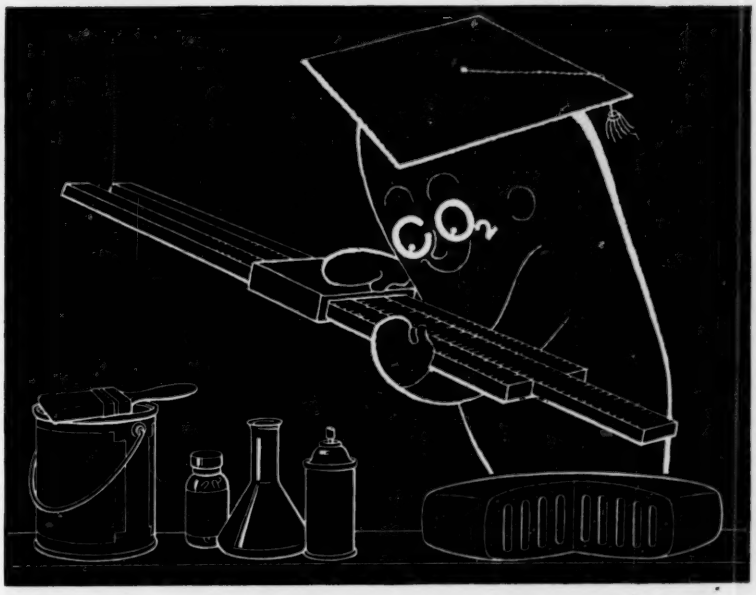


Replenisher

Maintains tank solution level and strength.

A new device known as the Replenisher automatically maintains solution-tank liquid level as well as chemical concentration of tank contents. According to company officials, the machine's simple construction assures foolproof operation.

When tank level drops, a float valve actuates a screw conveyor that accurately feeds dry chemicals from the hopper. At the same time, a solenoid valve sup-



Chances are...Pureco CO_2 has solved a problem like yours

Today Pureco CO_2 is helping to solve many industrial problems for researchers and production men everywhere. The applications of CO_2, one of the most versatile of chemicals, are practically unlimited.

TYPICAL APPLICATIONS

INERT GAS — REFRIGERANT — ACTIVE INGREDIENT

Pharmaceuticals	Insecticides
Dyes	Resins
Paint	Rubber Trimming
Lacquer	Plastics
Packaging	Vacuum Traps
Aerosols	Low Temperature Testing
Purging Tanks and Mains	Lyophilizing (low temperature drying)
Inert Pressure Transfer	Asbestos Cement Cure
Fumigant Carrier	Carbonation
Capsulating	PH Control
Powdering	Foam Rubber
Flushing Molten Metals	Water Treatment
Foam Plastic	Manufacture of Carbonates

If any of the above applications suggest related uses in your processing methods, we would be pleased to discuss them with you. Our wide technical experience in applying CO_2 in its solid (DRY-ICE), gaseous and liquid forms, to industrial problems is available to help you. Call your Pure Carbonic Representative today.

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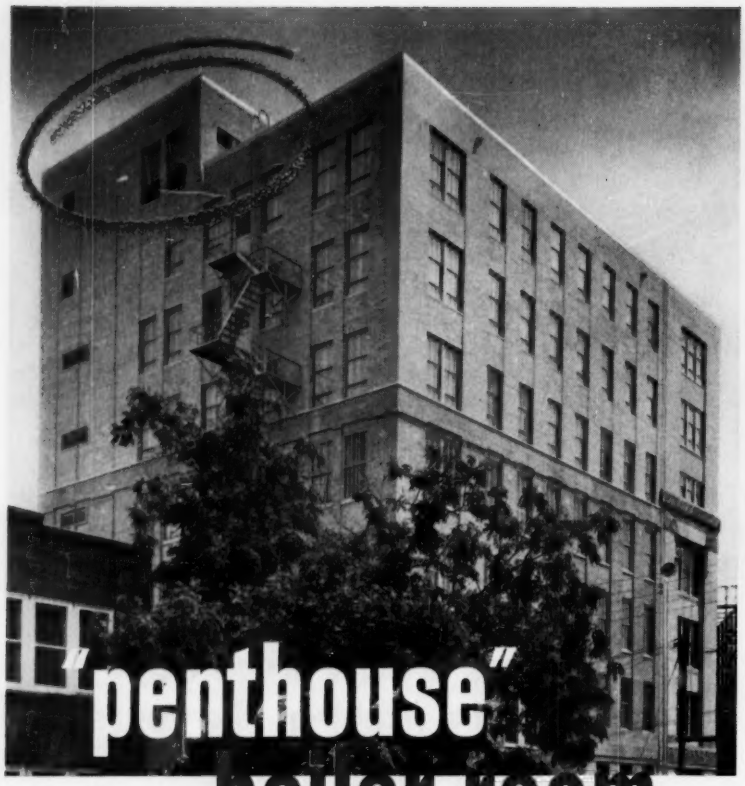


"penthouse" boiler room

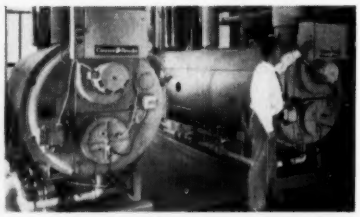
Cleaver-Brooks boilers at Lone Star Gas Company, *Ft. Worth, Texas,* demonstrate advantages of compact design and reliable, low-cost operation in year-round dual use of steam

The installation — these two Cleaver-Brooks 100-hp gas-fired boilers in penthouse boiler room atop eight-story office building, according to A. E. Emmet, Industrial Engineer, "are providing all steam needed for both heating and cooling of the entire building."

The advantages — "So compact are these CB boilers, we have almost five times the steam capacity in our penthouse that we had in an equivalent basement area. Our choice of 100-hp boilers was dictated by our new 236-ton absorption air conditioning unit which uses approximately 20 lbs. of steam per ton-hour's operation."

Efficiency — Mr. Emmett continues, "Since the Cleaver-Brooks boilers operate at a guaranteed minimum efficiency of 80% (as opposed to the 70% top for former boilers), our operating costs have been reduced about 10%, resulting in significant fuel savings per unit of steam produced.

"Further, the CB boilers guarantee 99% dry steam. Also, undivided responsibility for the design of a package-type boiler always works out to the customer's advantage and all parts are built to work as a unit."



Lone Star's two Cleaver-Brooks boilers are Model CB-700-100, 15-lb. design . . . deliver consistent, trouble-free service — 3000 lbs. per hr. in summer, 1000 lbs. per hr. in winter.

Cleaver-Brooks packaged boilers simplify installation, cut operating costs. For complete information, write Dept. B, 345 E. Keefe Ave., Milwaukee 1, Wisconsin.

Cleaver Brooks

ORIGINATORS AND LARGEST PRODUCER OF PACKAGED BOILERS

plies fresh water at the rate required for proper solution strength.

Mixing occurs without mechanical aid if the dry solids are readily soluble; otherwise, a tank agitator must be used.—**Cincinnati Cleaning & Finishing Machinery Co., Cincinnati, Ohio.** 183A

Stack Rings

Attach aluminum jackets to hot stacks.

According to the manufacturer, Premetco stack rings simplify attachment of aluminum jacketing around high stacks or non-insulated piping. Air-escape holes spaced around each ring permit unrestricted upward flow of heat—the jacket remains cool, thus eliminating discoloration of finish or injury to plant personnel.

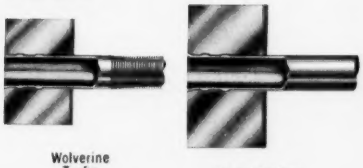
Spot welds hold rings to the stack. Or, for faster installation, the rings come with factory-attached jacketing; these 3-ft. sections quickly snap into place around the stack. The rings also come attached to aluminum ells to cover line bends.—**Preformed Metal Products Co., Inc., Shreveport, La.** 184A

(*Continued on p.* 189)

WOLVERINE
TUBE
Items of Interest to the Processing Industry

PUBLISHED BY WOLVERINE TUBE DIVISION

Trufin Type S/T is Interchangeable with Prime Surface Tube



Wolverine Trufin Type S/T Condenser Tubing

Prime Surface Condenser Tubing

Because it is designed specifically for use with shell and tube condensers, the dimensions of Wolverine Trufin Type S/T are such that it is completely interchangeable with prime surface tubing.

For example, the outside diameter of the finned section of the tube is no greater than that of the plain end, which permits Type S/T to be threaded and rolled into headers as easily as bare tube—using exactly the same techniques and retubing tools.

As an additional design feature, the wall of the plain end section is approximately two gauges heavier than the specified tube gauge. This provides a better bond at the tube sheet and offers additional protection against inlet erosion.

FIELD ENGINEERING SERVICE OFFERS SKILLED HELP

For the convenience of its customers Wolverine Tube maintains its Field Engineering Service — a staff of highly trained tubing technicians.

In addition to their own specialized backgrounds these men are backed by the experience and knowledge gained by Wolverine Tube during its years as a leading supplier of tubing for heat transfer applications.

Members of the Field Engineering Service group are available at all times to help solve problems in design, corrosion, tubing selection—or what have you. Next time you have a problem ask for a Wolverine Field Service Engineer — there is no obligation.

THE CASE OF THE UNUSED PRODUCTS COOLER

BY ERNEST DODD

Here's a true story which we think you'll find interesting. It concerns a problem engineers at a large Gulf Coast Refinery (near Houston), ran into with a product cooler that had insufficient surface to handle the required heat load.

Actually it isn't a very difficult problem. It happens frequently and until recently there was a standard solution: just design a bigger unit capable of handling the desired heat load. Of course it's expensive and it takes time —but it does provide a solution to insufficient heat transfer surface.

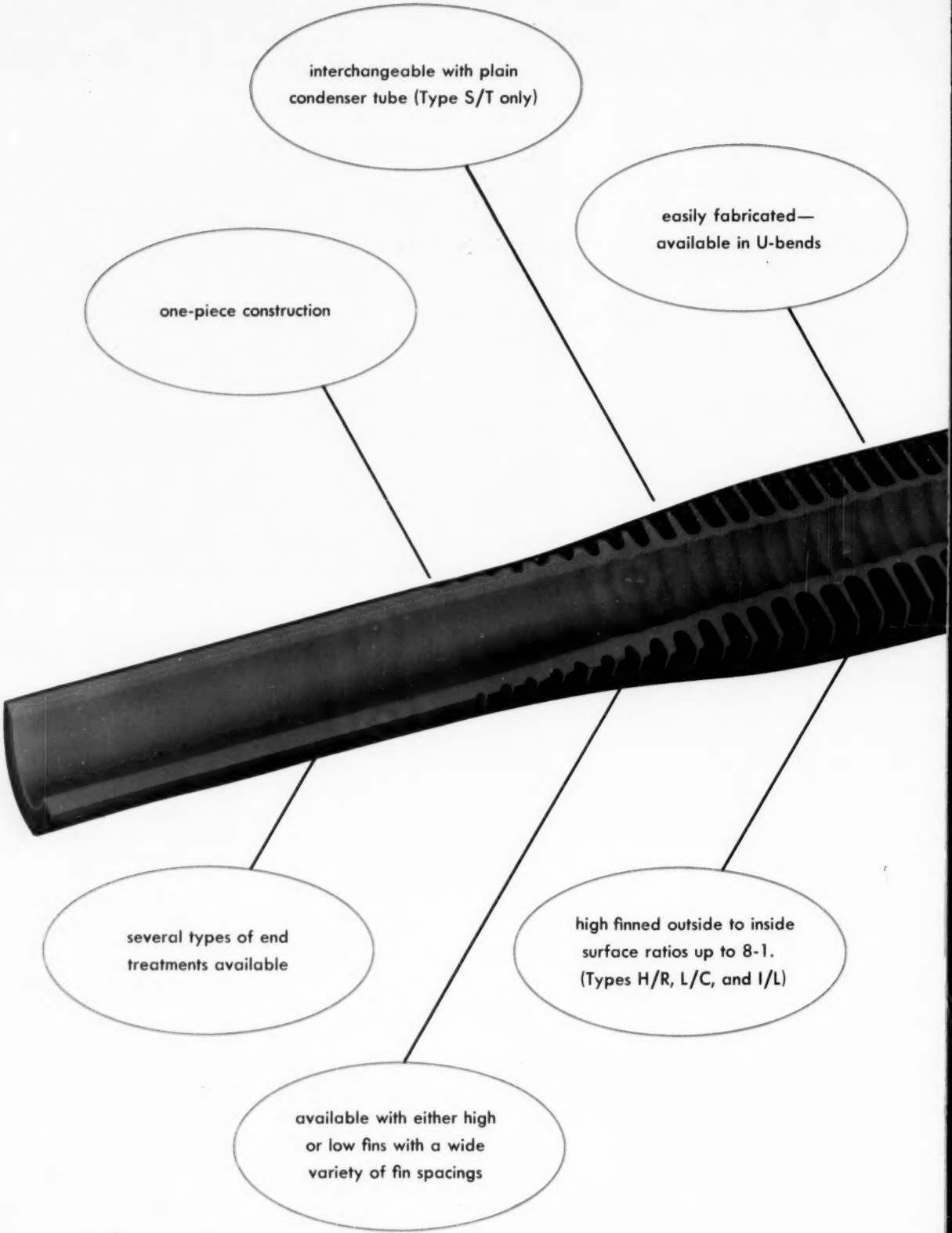
Well that's what happened here. The engineers took a look, figured out what was needed and a new exchanger was approved and ordered. Which should have been the end of the whole thing.

But you know how it is sometimes. While the refinery was waiting for the new unit to be built and shipped—the old one started to act up. The engineers looked it over and decided to retube—with Wolverine Trufin® Type S/T—the original, integrally-finned condenser tube.

Now here's the part of the story we like. All this happened two years ago. During this time the original cooler—which was retubed with Trufin Type S/T, has been continuously on stream and has easily been handling the desired increase in heat load. And the new unit? Well it has never been required.

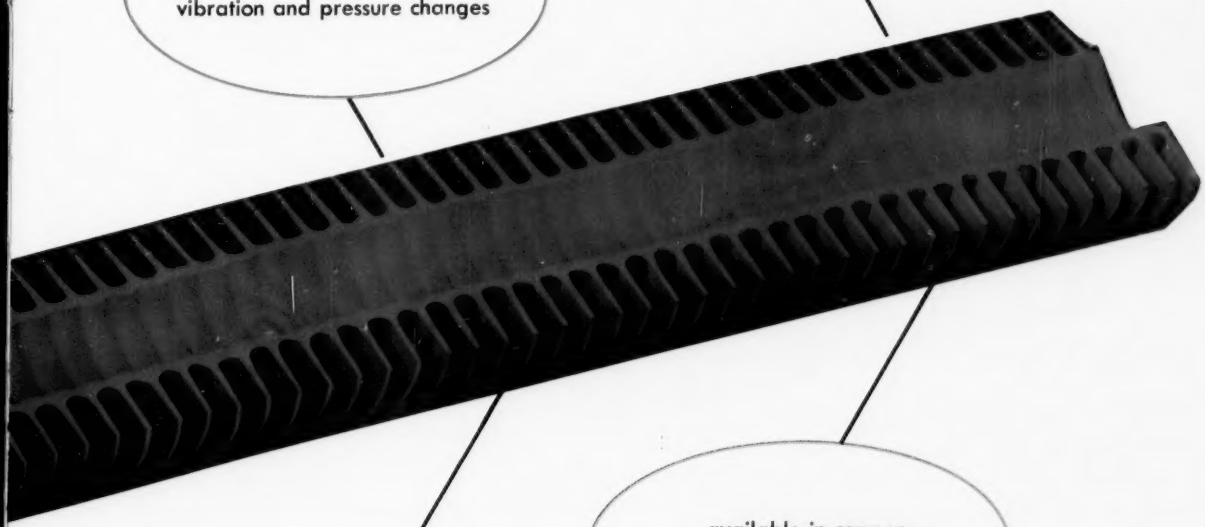
This is but another example of the countless installations where Wolverine Trufin Type S/T is helping the processing and refining industries do a better heat transfer job — at less cost.

If your company is contemplating the design of new equipment or retubing old, why not get more information about Wolverine Trufin Type S/T before going any farther. You'll be amazed and delighted at the way this integrally finned tube can increase capacity and reduce operating expense.


interchangeable with plain condenser tube (Type S/T only)
easily fabricated— available in U-bends
one-piece construction
several types of end treatments available
high finned outside to inside surface ratios up to 8-1. (Types H/R, L/C, and I/L)
available with either high or low fins with a wide variety of fin spacings

smooth extruded fins eliminate sharp angles and crevices

fins stand up under thermal shock, vibration and pressure changes



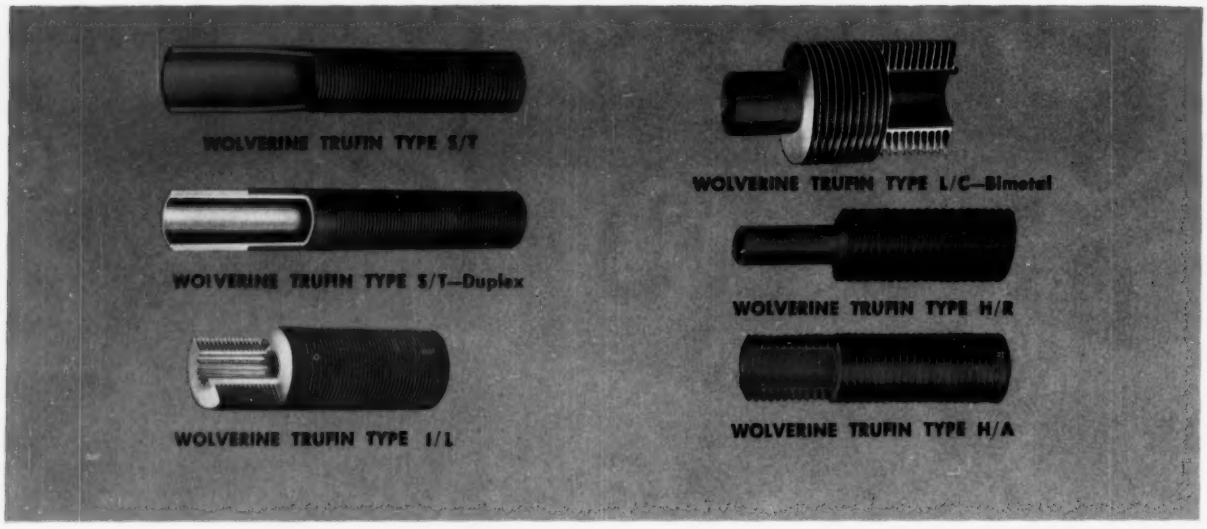
available in copper, copper alloys and aluminum

more BTU's per foot of tube

THIS IS WOLVERINE TRUFIN!

Look at the advantages—see for yourself what Trufin can do for you. Specify it for new installations and for retubing at turn-around time. You'll do a bigger job . . . boost production . . . save money, too!

WOLVERINE TUBE PIONEERED DEVELOPMENT OF INTEGRALLY-FINNED CONDENSER TUBE


WOLVERINE TRUFIN TYPE S/T
WOLVERINE TRUFIN TYPE S/T—Duplex
WOLVERINE TRUFIN TYPE I/L
WOLVERINE TRUFIN TYPE L/C—Bimetal
WOLVERINE TRUFIN TYPE H/R
WOLVERINE TRUFIN TYPE H/A

Since its inception in 1916, Wolverine Tube has devoted a great deal of its research and engineering facilities to problems encountered in the field of heat transfer.

Perhaps the most significant of the advances coming from this specialization was the development of Wolverine Trufin® —the original, integrally-finned condenser tube.

In bringing Trufin to its present superiority, Wolverine Tube has engaged in many activities widely separated from actual tube manufacturing.

For many years, for example, Wolverine has worked hand-in-hand with research groups at the University of Michigan. As a result of the tests and studies made during these research activities, theories have turned into facts and the formerly unknown field of finned tubing has become a known way. D. Q. Kern Associates have helped to pioneer additional design and application procedures using Wolverine Trufin. They have served as heat transfer consultants and their contributions have resulted in innumerable customer benefits and advances in the field of heat transfer.

In sharing its fund of finned-tube knowledge, Wolverine has worked closely with the fabricators of heat transfer equipment. For the benefit of its customers and industry in general, Wolverine also conducts a series of Technical Seminars dealing with integrally-finned tube and its applications.

Wolverine Tube is proud of its contributions to both heat transfer and finned tube knowledge. Next time your company requires extended surface tubing investigate Wolverine Trufin before you order. Remember, it is the original, integrally-finned condenser tube. Write, too, for a copy of the Wolverine Trufin catalog.

Speaking of heat transfer knowledge, we'd like you to meet Harry F. Powell, one of Wolverine Tube's two Technical Sales Representatives located in the Southwest. In addition to his own extensive engineering background, "Fil" Powell has undergone much specialized training at Wolverine plants and is a graduate of the Wolverine Heat Transfer Course. He recently was elected V-P of the Heat Transfer Engineers Society in Texas. If you're located in the Southwest, you can get in touch with "Fil" at 2 North York St., Houston 3, Texas. Give him a call next time you need tubing or have a tubing problem.

CALUMET & HECLA, INC.
CALUMET DIVISION
URANIUM DIVISION
GOODMAN LUMBER DIVISION
WOLVERINE TUBE DIVISION
In Canada:
CALUMET & HECLA OF CANADA LIMITED
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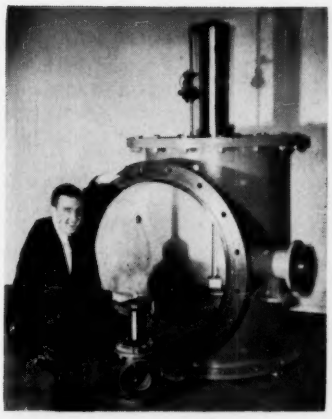
WOLVERINE TUBE
DIVISION OF
CALUMET & HECLA, INC.
17232 Southfield Road
Allen Park, Michigan
Manufacturers of Quality-Controlled Tubing and Extruded Aluminum Shapes

Wolverine Trufin is available in Canada through the Unifin Tube Division, London, Ontario.

PLANTS IN DETROIT, MICHIGAN AND DECATUR, ALABAMA. SALES OFFICES IN PRINCIPAL CITIES.

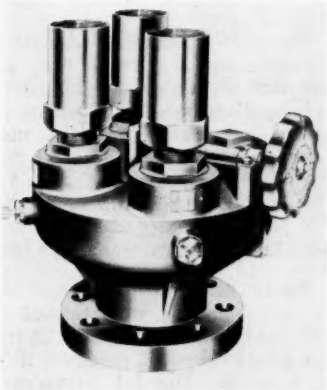


High-Vacuum Valve

Huge unit for production melting, heat treating.

A new, 36-in., air-operated valve for very large high-vacuum systems comes in eight, angle-type models. Designed to isolate vacuum pumps from process chambers open to the atmosphere, valves have leak rates of 0.1 micron cu. ft./hr.

Materials of construction include stainless or mild steel. Units can be furnished with or without roughing connection, and with flanged or welded fittings. A dish-shaped disk assures high strength without sacrifice of weight.—**NRC Equipment Corp., Newton, Mass. 189A**



Relief Valve Manifold

Eliminates shutdown of tanks in NH_3 service.

A new RegO three-port manifold makes it possible to remove any one of three safety relief valves protecting an NH_3 tank

Consider . . .

BETHLEHEM'S EXPERIENCE

when selecting your agitated dryers

Bethlehem has wide experience in making continuous and batch dryers to operate under vacuum or pressure for producers in the field of titanium tetrachloride, starch, lithium-chloride, naval stores, and other chemicals.

Bethlehem has made a thorough study of agitation for different operating conditions, and offers ribbons, plows, paddles, or a combination of these three types, as required for your special needs. For example, in processing plastic materials, a plow provides the required shearing action, and at the same time, keeps horsepower consumption stable and at a minimum. The plow type agitator also keeps dusting or reduction to fines at a minimum.

For blending, a spiral ribbon agitator is indicated. These agitators are available in double or triple flights.

Bethlehem agitators are designed to ensure:

1. Highest possible surface renewal rate.
2. High discharge rate.
3. Good mixing, with low size reduction.
4. Consistent power input.
5. Proper degree of shear.

For complete data regarding Bethlehem horizontal Dryers write for our 4-page illustrated Technical Bulletin #301.

For information regarding other equipment in the Bethlehem line, including autoclaves, kettles, chemical castings, and reactors, see our 8-page insert in "Chemical Engineering Catalog."

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BETHLEHEM PENNSYLVANIA

Improve product quality and uniformity
Specify, insist on
Ludlow-Saylor
WIRE CLOTH & SCREEN
FILTERING, STRAINING, SIZING
. . . whatever the job . . . if you have a problem of corrosion, high pressure, vibration, heat, abrasion . . . L-S has the cloth or screen in stock to meet your exacting requirements, or can precision-weave it to your specifications.
L-S Wire Cloth or Screen insure more uniform product quality, higher output—lasts longer, cuts downtime and replacement costs. The best actually costs less . . . Be sure you order L-S.
Write for Condensed Screen Reference Catalog
L-S Cloth and Screens are woven from any steel including high-carbon, oil-tempered, stainless and other alloys; Monel, bronze, copper, brass or any metal that can be woven into wire.
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SINCE 1856
OVER 100 YEARS PROGRESS AND SERVICE

while the tank is under pressure. Tank shutdowns during periodic relief valve testing are thus eliminated—the remaining two valves provide ample relief capacity for tanks up to 30,000 gal. in size.

Manipulation of a handwheel positions a revolving disk under the valve to be removed. Numbers on the handwheel enable correct selection of disk location. Valve construction is forged aluminum; manifold port size is 4 in. dia.—**The Bastian-Blessing Co., Chicago, Ill. 189B**

BRIEFS

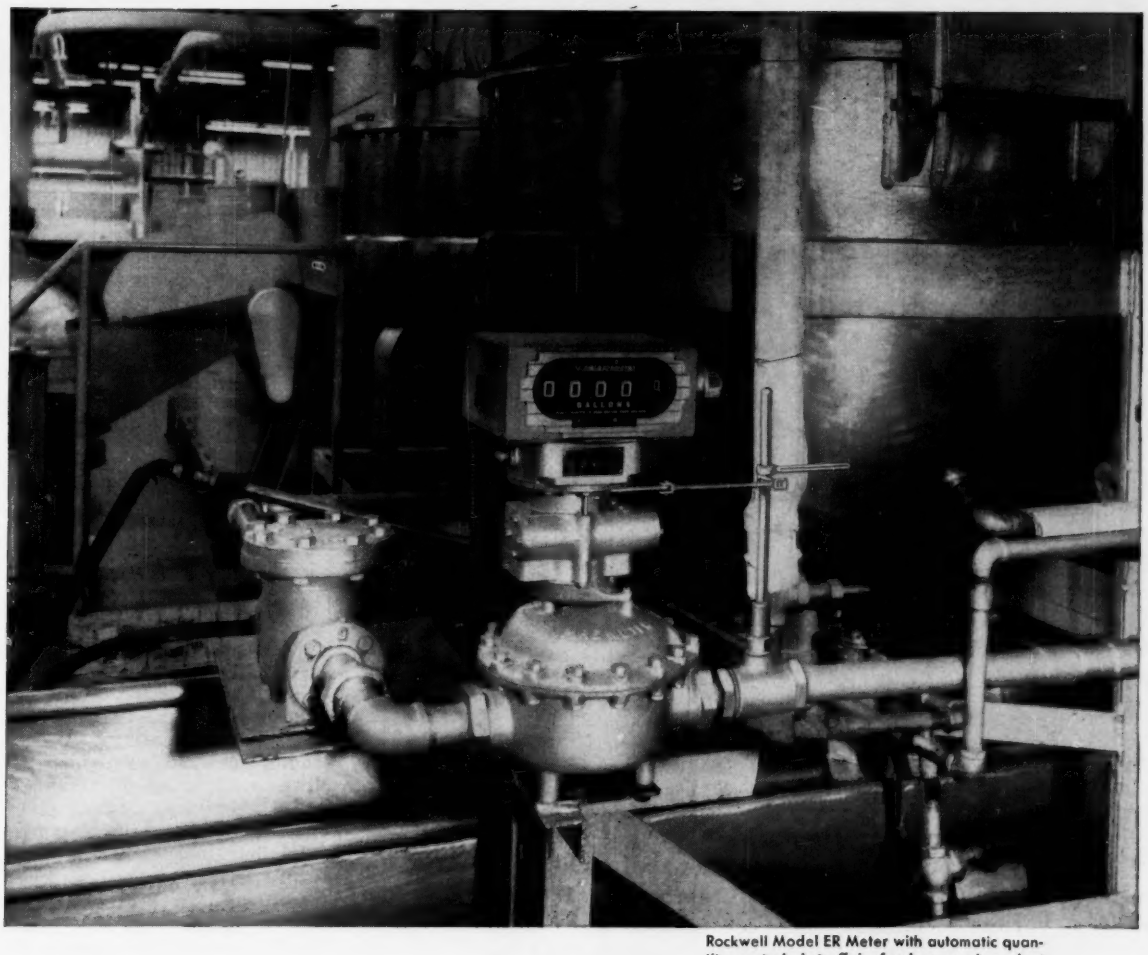
Computer-control system measures and records process variables, and also calculates heat rates, efficiencies, power consumption, etc. for operator guidance. System consists of a Beckman 123 data processor and a Bendix G-15 computer. — **Beckman/Systems Div., Anaheim, Calif. 190A**

Drying oven comes with or without dehumidifier and in different sizes with different drawer combinations. Typical applications include dehydration of pharmaceuticals and pre-mold conditioning of plastics. Temperature range to 450 F.—**Despatch Oven Co., Minneapolis, Minn. 190B**

Storage batteries with replaceable heat-resistant cells are now available for industrial applications. Addition or removal of cells regulates voltage and amperage, and permits easy maintenance in event of cell failure.—**Scranton Cellomatic Battery Corp., Archbald, Pa. 190C**

Spray nozzle of improved design speeds up removal of tenacious materials during spray-down of pressure filter leaves. The jet provides a greater velocity with normal flow rates, thus reducing consumption of cleaning medium. —**Hercules Filter Corp., Hawthorne, N. J. 190D**

Swivel joint features a new design that enables interchangeability of packing without line



Rockwell Model ER Meter with automatic quantity control shut-off in food processing plant

Batch it, blend it, or just plain account for it!

IT'S GOOD BUSINESS TO METER ALL LIQUIDS

Wherever liquids are stored, mixed or used in plant operations, you can save time, money and improve efficiency with Rockwell industrial meters. With meters you can batch, blend and control formulas with precision. Handling volatile liquids, metering provides the safety of a closed piping system and guards against contamination.

Rockwell industrial meters are valuable accounting tools. Thousands use them for in-plant cost identification purposes, for inventory control—even to guard plant security.

You can measure most any piped liquid with Rockwell meters—oils, liquors, paints, chemical solutions—over 50 liquids in all. Use the coupon for full details.

CLIP COUPON—MAIL TODAY!

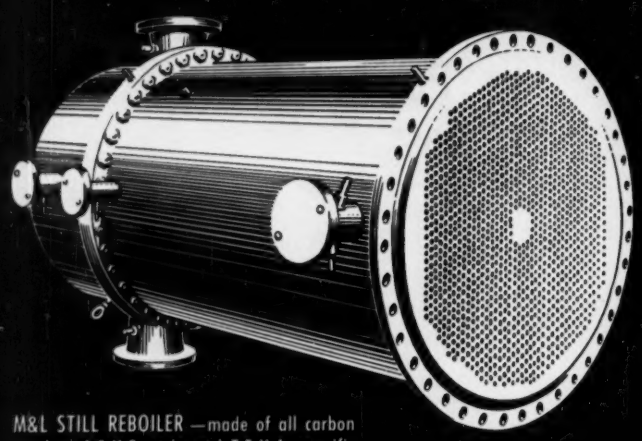
INDUSTRIAL METERS

another fine product by

ROCKWELL

ROCKWELL MANUFACTURING CO.
Pittsburgh 8, Pa.
Gentlemen:
I am interested in measuring_____ (Name of Liquid)
Pipe Size_____"
Working Pressure_____psi Temperature_____°F max.
Max. Flow Rate_____gpm Min. Flow Rate_____gpm
Your Name_____
Company_____
Street_____
City_____ Zone____ State_____

MANNING & LEWIS



M&L STILL REBOILER —made of all carbon steel to A.S.M.E. code and T.E.M.A. specifications. (Design temp. 450°F, weight 9500 lbs., Shell—44" dia., 8'9" length, 1-1/16" thick, 1500 steel tubes—¾" O.D. x 14 B.W.G.)

Many years of experience have given us an unusually thorough knowledge of the appropriateness, adaptability and qualities of fabrication of a wide variety of metals. This accumulated knowledge, coupled with our engineering experience and the important "extras" in fabrication, is your assurance of practical trouble-free equipment at the lowest possible cost.

It is impossible, in a field requiring such wide diversification, to illustrate, or even list all the products we have been called upon to supply. An excellent case in point, however, is the Reboiler above. In its fabrication, X-Raying was performed to assure perfect welds. This example is typical of the "extra" care you can expect and get from Manning & Lewis.

Call on us the next time you need equipment. We are fully qualified to design and fabricate to all codes.

M&L MANNING & LEWIS

ENGINEERING COMPANY

Dept. A, 28-42 Ogden Street, Newark, New Jersey

DESIGNERS & MANUFACTURERS OF QUALITY HEAT EXCHANGE EQUIPMENT

removal to provide for multiple services. Maximum temperature rating is 600 F. at 200 psi. Sizes range from ⅜ to 4 in. — **Chiksan Co., Brea, Calif.** 190E

Generating plants driven by diesel engines are now available in eight new series having an over-all capacity range of 50 to 200 kw.—**D. W. Onan & Sons, Inc., Minneapolis, Minn.** 192A

Bearing lubricator holds a reservoir of grease and automatically injects it as needed. Position of pressure cup signals when a refill is necessary. Price runs $18.25 per dozen.—**Anchor Chemical Co., Cleveland, Ohio.** 192B

Butterfly valves rated for 125 psi. now come in an expanded size range for 4- to 48-in. lines. All models surpass AWWA specifications.—**B-I-F Industries Inc., Providence, R. I.** 192C

Centrifugal blowers feature airfoil-shaped blades that improve efficiency and silence operation. Sizes of the new line vary from 440 cfm. at ¼ in. H_2O to 460,000 cfm. at 16 in.—**Joy Mfg. Co., Pittsburgh, Pa.** 192D

Equipment Cost Indexes . . .

	Sept. 1958	Dec. 1958
Industry		
Avg of all.....	230.9	231.3
Process Industries		
Cement mfg.	223.3	223.7
Chemical	232.3	232.7
Clay products	217.0	217.4
Glass mfg.	219.3	219.7
Paint mfg.	222.8	223.1
Paper mfg.	223.8	224.2
Petroleum ind.	227.5	227.8
Rubber ind.	230.3	230.6
Process ind. avg..	228.6	228.8
Related Industries		
Elec. power equip...	236.0	236.4
Mining, milling	233.7	234.1
Refrigerating	260.3	260.6
Steam power	218.1	218.4

Compiled quarterly by Marshall and Stevens, Inc. of Ill., Chicago for 47 different industries. See Chem. Eng., Nov. 1947, pp. 125–6 for method of obtaining index numbers; Feb. 24, 1958, pp. 143–4 for annual averages since 1913.

News from
National Carbon Company
Division of Union Carbide Corporation • 30 East 42nd Street, New York 17, N. Y.
Sales Offices: Atlanta, Chicago, Dallas, Kansas City, Los Angeles, New York, Pittsburgh, San Francisco. IN CANADA: Union Carbide Canada Limited, Toronto

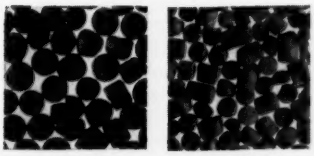
National Carbon representatives expand your engineering force

J. M. BROWN
SALES ENGINEER

After graduating from Purdue University with a B.S. in Chemical Engineering, Brown spent five years in the Cleveland Sales Engineering Department developing new products, equipment design, and performing field installation and maintenance work.

For the past five years, Jim has been working with the chemical industry as a field sales engineer on the application and use of carbon, graphite and "Karbate" impervious graphite products.

New Size Activated Carbon Pellets Available for Catalyst Support

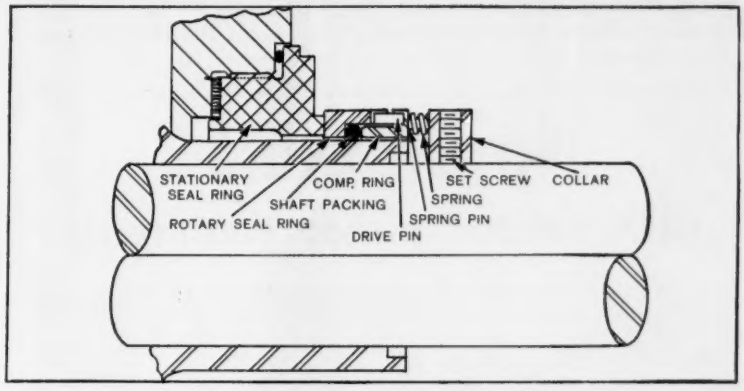


4/6 MESH 6/8 MESH

A *new "Columbia"* activated carbon grade CXC, which has been designated as a catalyst support, is now produced in smaller 6/8 mesh pellets.

The new size pellets have all the properties associated with the original 4/6 mesh size such as high activity, strong and uniform shape, high metal salt pickup, and low active ash. *For details, contact National Carbon Company, 1300 Lakeside Avenue, Cleveland 14, Ohio.*

"Karbate" Pumps with choice of Mechanical Seals assist Seal Standardization



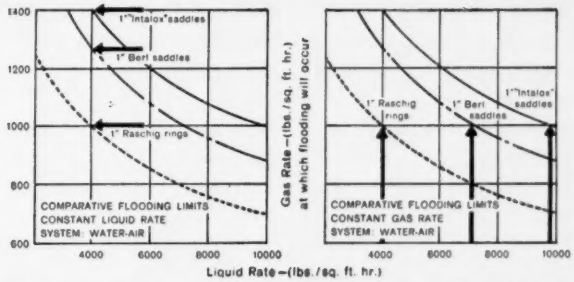
"Karbate" pump seal arrangement with "Durametallic" seal

"Karbate" impervious graphite pumps Type C Model CA are available with either NATIONAL CARBON or "Durametallic" mechanical seals. The "Durametallic" seal arrangement is offered to partially meet the trend within chemical plants to standardize on one type of mechanical seal for rotary equipment.

NATIONAL CARBON's design which has proved satisfactory for many years is standard equipment on Model CA pumps. "Durametallic" seals will be supplied as optional equipment.

"Durametallic" seals can be installed on any "Karbate" impervious graphite pump Type C Model CA now in service by simply replacing the standard stationary and rotary seal components.

Carbon "Intalox" Saddles provide highest Efficiency and unmatched Corrosion Resistance



Carbon "Intalox" saddles, developed jointly by National Carbon Company and U.S. Stoneware Company, combine the operating efficiencies of the "Intalox" design with the almost universal corrosion resistance feature of carbon. These saddles can be used in stripping, absorbing, and scrubbing applications where hydrofluoric acid, hot alkalis, phosphoric acid, mixtures of hydrofluoric-sulfuric and hydrofluoric-phosphoric acids are present. Carbon saddles withstand abrupt temperature changes without danger of cracking or spalling.

The above graphs show the higher efficiency of "Intalox" saddles as compared to Raschig rings and Berl saddles. The availability of carbon saddles permits the designing of smaller scrubbing, stripping and absorbing towers for highly corrosive applications. Also, capacity of existing towers can be increased by using carbon "Intalox" saddle packing. *For details, contact National Carbon Company, P. O. Box 6087, Cleveland 1, Ohio.*

NATIONAL TRADE-MARK

"National", "Columbia", "N" and Shield Device, "Karbate" and "Union Carbide" are registered trademarks of Union Carbide Corporation

UNION CARBIDE

EQUIPMENT TODAY FOR THE CHALLENGE OF TOMORROW

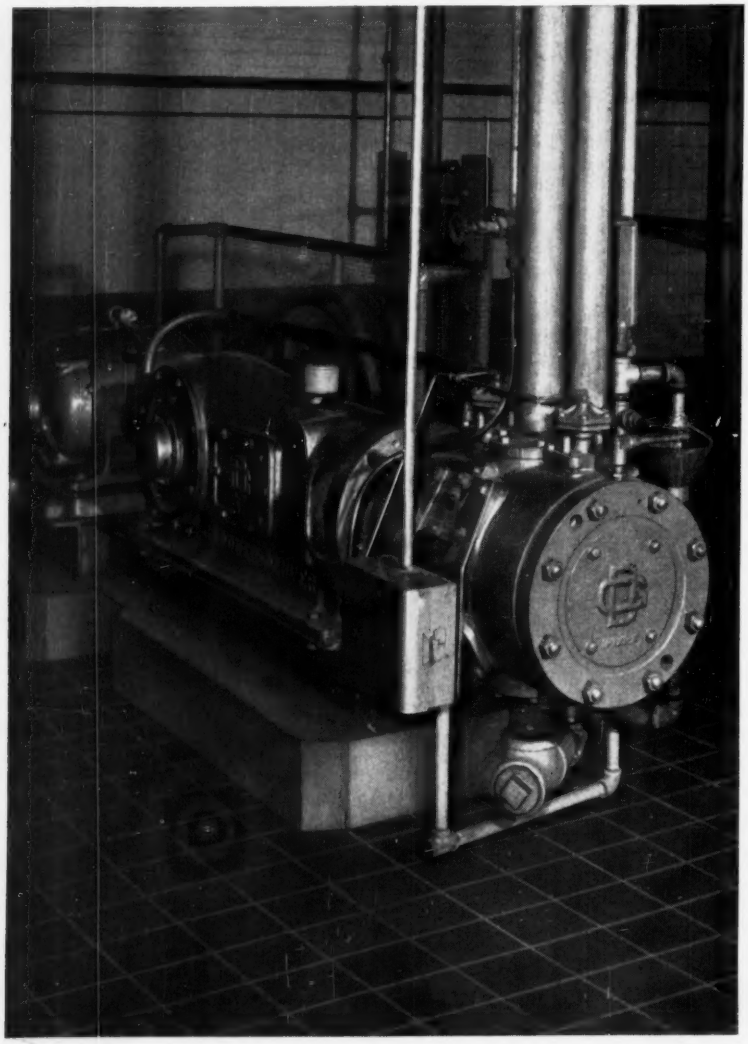
GARDNER DENVER

Pure, oil-free air that won't taint food, beverages or chemicals . . . won't clog sensitive control instruments . . . won't foul air-sprayed finishes. That's only one of the benefits when you install the CRX carbon piston air compressor. Carbon parts need no oil or water lubrication in the honed cylinder. Discharged air is pure and clean. Sizes from 100 to 1410 c.f.m. displacement. Write for Bulletin CRC-10. Ask about the smaller CACB oil-free compressor. Gardner-Denver Company, Quincy, Illinois.

In Canada: Gardner-Denver Company (Canada), Ltd., 14 Curity Avenue, Toronto 16, Ontario

No oil taint

...CRX carbon piston compressor



TECHNICAL

Why and How of Glass

GLASS ENGINEERING HANDBOOK. By E. B. Shand. McGraw-Hill Book Co., New York. 484 pages. $10.

Reviewed by A. Paul Limbach, Union Carbide Plastics Co., Development Laboratories, Bound Brook, N. J.

Here's a compilation of exacting data which teaches the "why" and "how" of glass technology. "Why" to use glass and "how" to use glass are questions often asked and this book contains many of the answers.

The book assumes a practical approach to the usage of glass, with many tables and curves to simplify its application. A goodly portion is devoted to glass technology with detail on composition, properties, chemical resistance, stress release, glass metal seals, strength, stress determination, radiation, emissivity and high energy radiation effects. Data is presented on the subject of manufacturing tolerances, designing glass objects and designing for glass-metal combinations. Many new types of glass such as photosensitive glass, glass ceramics and electrically conductive glass are included.

First hand experience is obvious in the coverage of applications, including glass containers, gage glass, laboratory glass, electric lamps and electric circuit components. An entire section is devoted to fibrous glass, its properties, and its application. Insulation, textile fibers and reinforced plastic are covered well with charts and data on properties.

It is an excellent reference manual for general information and should be a valuable tool for the applicator or engineer who desires to use and capitalize on the unique properties of glass.

However, there are some suggested improvements.

There is no description on how to observe the strain in glass

BOOKSHELF

J. B. BACON

through the use of a polariscope. A description of how to use and how to construct a cheap unit with a light bulb, a condensing lens and two polaroid plates would be helpful.

The use of epoxy and glass fibers for reinforced structures is growing rapidly. There is additional property information on this subject which can be obtained from industrial sources.

No mention was made of reflecting glass beads for highway marking, glass beads for filler and glass balloons for fillers with epoxy and other plastic. These are all growing and important fields.

There is very little information on optical glass. Areas that could be covered briefly are: Types of lenses, plano, single vision, one piece bifocal, and fused bifocal. A little about the molding, grinding, and polishing of these types would also be interesting.

BRIEFLY NOTED

AIR POLLUTION LABORATORY METHODS MANUAL. *Los Angeles County Air Pollution District, 434 S. San Pedro St., Los Angeles 13, Calif.* $12.50. Contains detailed descriptions of more than 15 methods used in laboratory analysis of samples collected from atmosphere or specific sources.

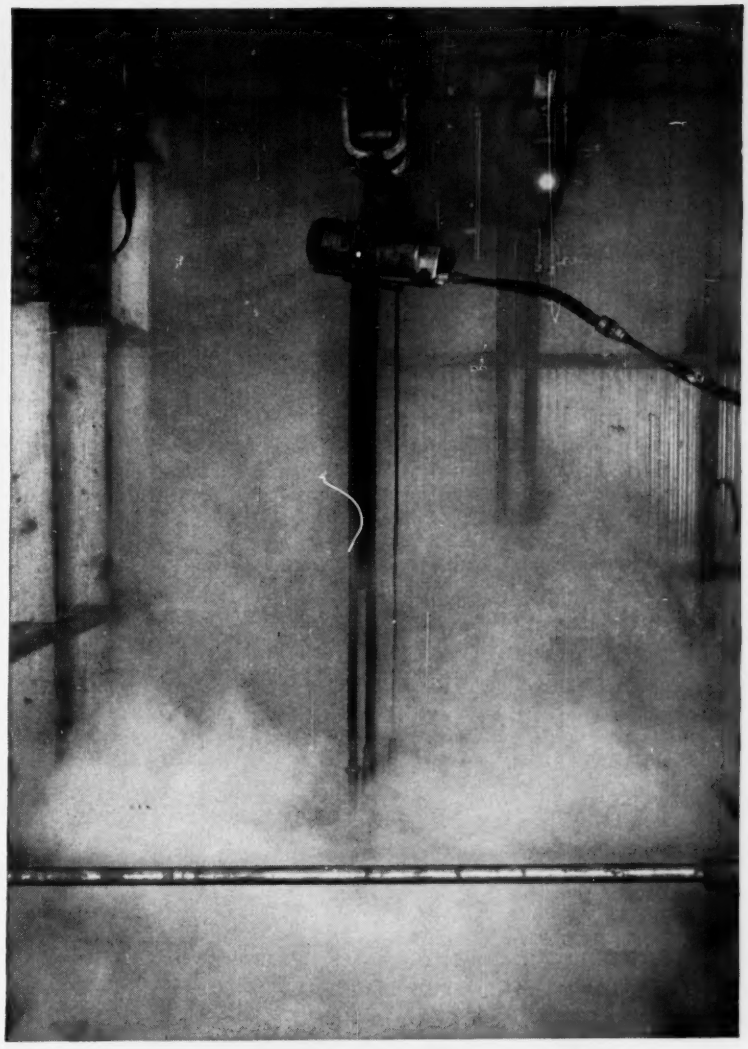
SINGLE-PHASE TRANSFER OF LIQUEFIED GASES. *42 pp. By Robert B. Jacobs. Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C.* 30¢. Presents a general system of equations and empirical information required for design of long-distance liquified-gas transfer systems.

MORE NEW BOOKS

PROCESSING OF THERMOPLASTIC MATERIALS. Edited by Ernest C. Bernhardt. Reinhold. $18.

THE ATOM AND THE ENERGY REVOLUTION. By Norman Lansdell. Philosophical Library. $6.

BIOCHEMICAL PREPARATIONS, VOL. 6. Carl S. Vestling, Editor-in-Chief. Wiley. $5.25.



Air hoist runs cool
despite heat and humidity

Maintenance of processing equipment calls for steam, plus a hoist that laughs at constant heat and humidity. That's why so many chemical plants and refineries favor this ½-ton Gardner-Denver 86-1V10, air hoist (one of our complete line with capacities from 150 lb. to two tons). Reasons for this preference for Gardner-Denver hoists include: fire-safe, nonsparking operation; they provide a positive, steady lift; they possess every other feature required for easy, safe load spotting. Write for Bulletin 86-1.

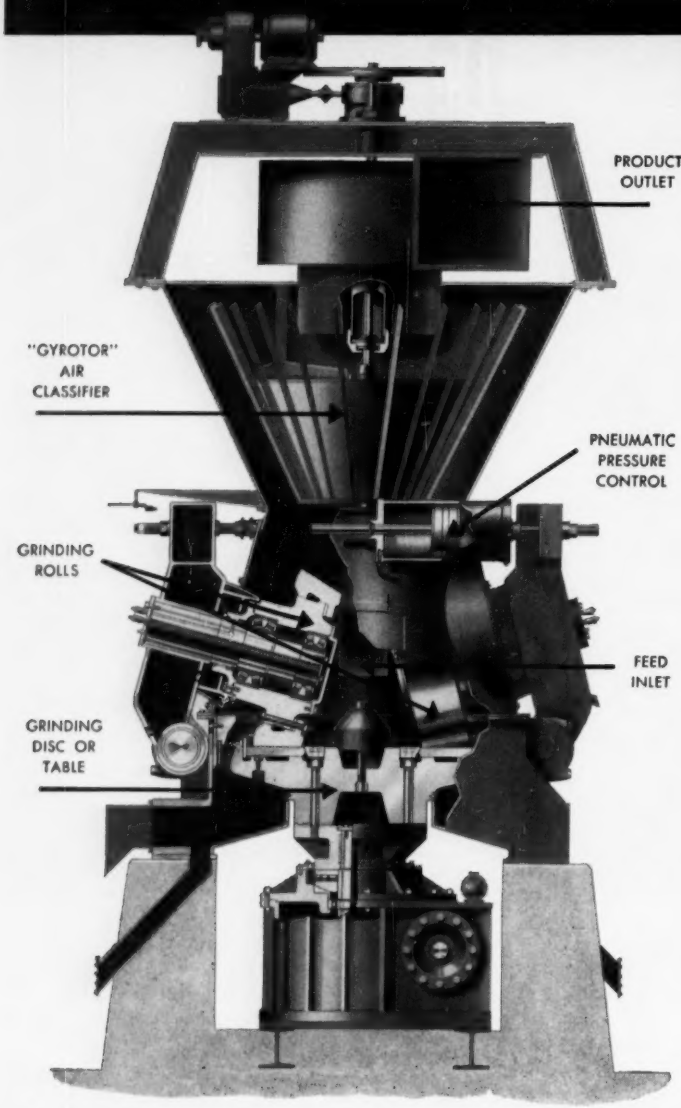
EQUIPMENT TODAY FOR THE CHALLENGE OF TOMORROW

GARDNER-DENVER

Gardner-Denver Company, Quincy, Illinois

In Canada: Gardner-Denver Company (Canada), Ltd., 14 Curity Avenue, Toronto 16, Ontario

DISC-ROLL MILL



The Hardinge Disc-Roll Mill is applied to dry grinding of minerals such as talc, limestone, coal, phosphate rock, bauxite, clays, celestite, and gypsum.

The Disc-Roll Mill incorporates pneumatic roll-loading. Since the pressure on the rolls can be released or increased at will, complete flexibility of operation results. The problem of over-loading is eliminated. Also, the Hardinge "Gyrotor" Classifier is standard equipment on the Disc-Roll Mill. This classifier provides very close control of the finished product over a wide range of sizes. Ask for Bulletin 52-11

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LETTERS:

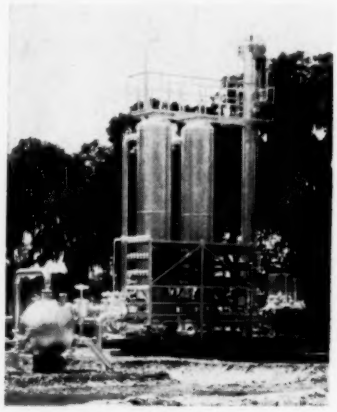
No Longer a Teacher

Sir:

An error in my biographical sketch apparently slipped through your careful editing of my article on "Joint Products and Byproducts" (Dec. 29, pp. 61-62).

While I have taught summer session at MIT (back in 1948), I do not now. I hope this letter will remove any surprise on the part of MIT or my present employer.

A. F. DERSHOWITZ
General Electric Co.
Waterford, N. Y.



More on Gas Adsorbers

Sir:

In your Dec. 15 issue (pp. 72-74) is an article entitled, "Adsorbers Now Open New Sources of Gasoline." This article makes some statements that are not factual:

1. You state that Parkersburg aims only to recover pentanes-plus. This is not true. We use the pentanes-plus content as a criterion to show the richness of the stream. We have made several proposals to various customers to recover LPG as well as gasoline. It is not necessary to have closed-system regeneration in order to do this, as long as ample heat exchange is used to condense the hydrocarbons to the proper temperatures.

2. You state that one year is a relatively long operating life for

PRO & CON

C. H. CHILTON

desiccant. We have in service several short-cycle dehydration units which have been operating in excess of three years without noticeable decline in adsorbing efficiency.

3. You state cycle times running around 45 min. Our three-tower units have cycle times as short as 10 min., whereas our two-tower units have cycle times from 25 to 45 min.

W. B. ADAIR
Parkersburg Rig & Reel Co.
Houston, Tex.

Who Owns the Blueprints?

Sir:

In you July 28 issue (pp. 127-130) your headline poses the question, "Does Your Employer Own Your Knowledge?" On page 172 of your Oct. 20 issue, the headline is: "THIS KNOWLEDGE . . . Belongs to the Employer."

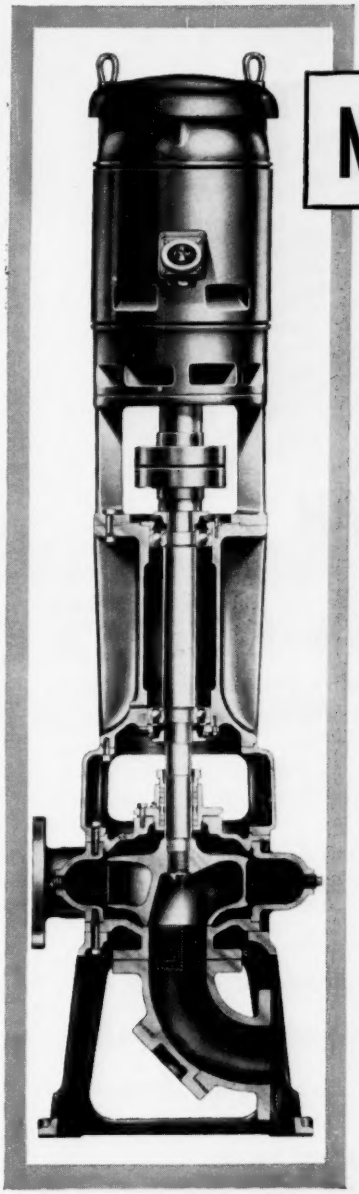
Contrary to the view that *Chemical Engineering* seems to take, I don't believe that the professional societies, the industry or the courts contend that an employer owns the knowledge of its professional people. In our own case the major issue involved "the taking of documents, drawings, formulae, and the like." In the cases cited it appears the wrongful act generally involved a rendition to a secondary employer of the property of a precedent employer, yet you never mentioned this fact in the July 28 issue.

In your Oct. 20 issue you refer to the documents but leave the clear impression that such documents of an employer represent "knowledge" of the employee. Actually, this "stolen" material was not even the work product of the taking ex-employee. Engineering and professional knowledge of the employee, as I understand it, was only incidentally involved in these particular cases.

As I have read these articles, I have been struck with the fact that to a great degree they give the impression of the big, bad

For higher pumping efficiency

of solids in suspension!



NEW

Fairbanks-Morse

5440A Non-Clog Pumps

Ideal for pumping unscreened liquids with large solids in suspension

- industrial wastes
- sanitary sewage disposal
- industrial processes

Here is your answer to higher efficiencies wherever you are pumping solids in suspension!

All-new Fairbanks-Morse 5440A Non-Clog Pumps feature quick, easy convertibility between any of the many vertical and horizontal types. Power requirements of the pump are always perfectly matched to the electrical and mechanical components. Precision-machined centering fits assure accurate alignment. Exclusive F-M bladeless impeller design minimizes maintenance by preventing clogging from solids and stringy material. The 5440A is only one of many F-M solids-handling pumps designed to meet a broad range of requirements. For information, write Fairbanks, Morse & Co., 600 S. Michigan Ave., Chicago 5, Ill.

Ask for new 5440A BULLETIN!

FAIRBANKS-MORSE

a name worth remembering when you want the BEST

ELECTRIC MOTORS • DIESEL, DUAL FUEL AND GAS ENGINES • PUMPS
COMPRESSORS • GENERATORS • MAGNETOS • HOME WATER SYSTEMS

*FIRST LINE

Extended-Surface

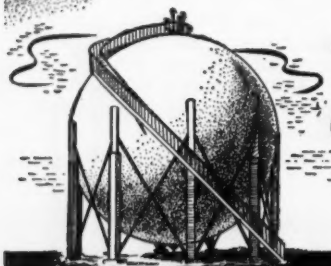
HEAT EXCHANGERS

ASK THE AEROFIN MAN

Specify Aerofin and you specify high efficiency, long service life and low maintenance and service costs.

Take advantage of Aerofin's unequalled experience, production facilities, and materials-testing and design research — of Aerofin's complete engineering service at the plant and in the field.

* *Aerofin makes extended heat surface exclusively — not as a by-product, not as a side-line.*



Throughout the Chemical Industry —

Aerofin units do the job Better, Faster, Cheaper

AEROFIN CORPORATION 101 Greenway Ave. Syracuse 1, N. Y.

Aerofin is sold only by manufacturers of fan-system apparatus. List on request.

PRO & CON . . .

company persecuting the poor, innocent engineer.

All of us agree that it is difficult to put into exact wording what might be called the stock-in-trade knowledge of the engineer. Yet it is very rare that we have anything of the nature of betrayals in the engineering profession.

In the case in question, the taking of blueprints in considerable quantity from one employer to another can hardly be looked upon as innocent or unplanned. Maybe you would like to write another article entitled, "Does the Employer Own His Own Blueprints?"

FRANCIS J. CURTIS
Monsanto Chemical Co.
St. Louis, Mo.

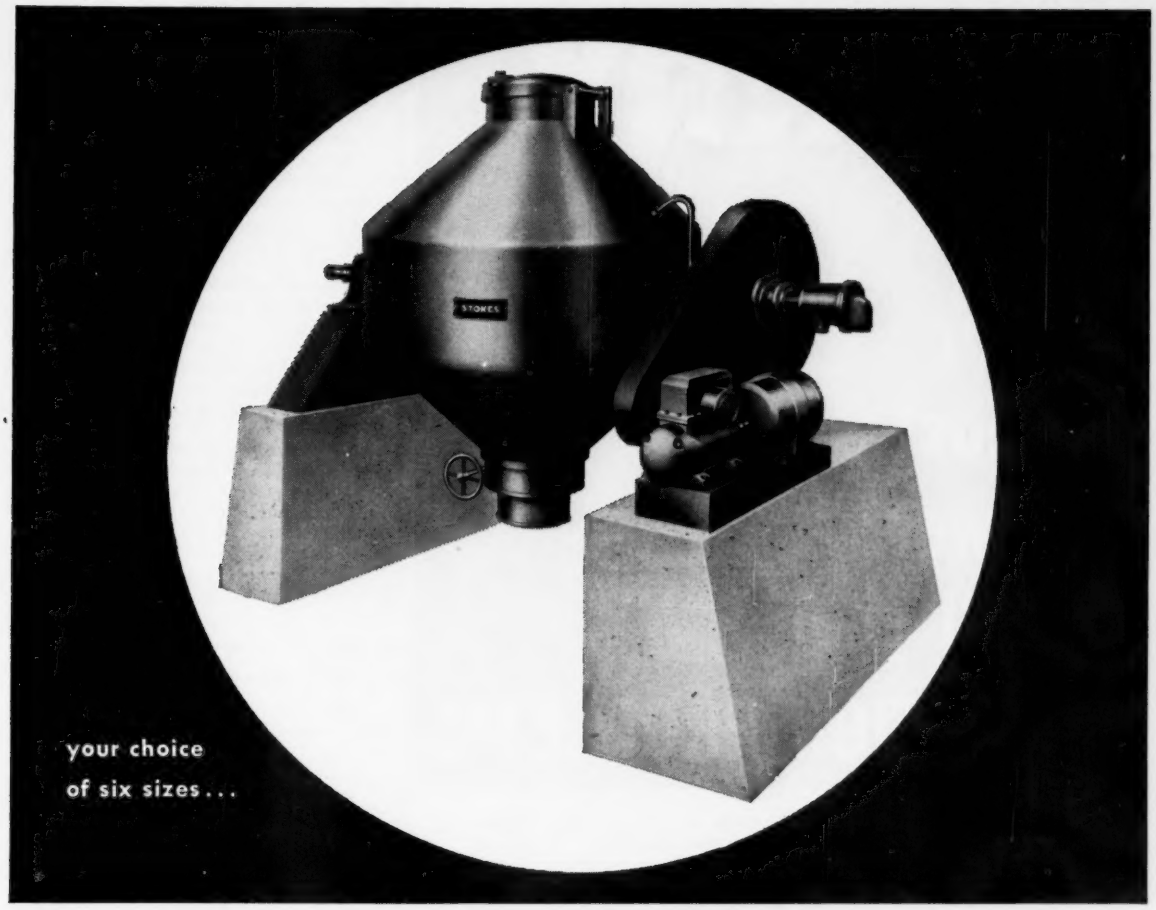
▶ *We completely agree with Mr. Curtis as to the ethics involved when an engineer knowingly misappropriates an employer's documents. We said in our July 28 article, "We do not condone the actions of any employee who deliberately takes as his own that which belongs to someone else."*

We also agree that use of the word "knowledge" in our Oct. 20 headline was questionable; our intent was to convey to the casual reader the immediate connection of this story with the July 28 article. We did not intend to create the impression that we sided with the engineer who had stolen confidential engineering drawings and price sheets.

However, our interest in this subject goes far beyond the ownership of mere documentary data. The important question posed by the Monsanto-Miller case was not who owned the 102 documents in question; it was the extent to which Miller could apply to everyday engineering practice the knowledge that he carried forever in his mind.

Judge Christensen's decision, which we studied carefully from beginning to end and reported in our June 2 issue (p. 43), upheld Monsanto's employee contract which forever forbids Monsanto employees from disclosing or using Monsanto's trade secrets and confidential know-how. Even information acquired via observation and conversation, whether carried in the mind or on paper, was included.

Furthermore, the judgment against Miller (reported in our Aug. 25 issue, p. 51) enjoined Miller "permanently and perpetually" from using confidential Monsanto information as the basis for exercise of engineering judgment



Stokes Conical-Shaped Rotating Vacuum Dryers

As part of the extensive line of vacuum drying equipment offered by Stokes, this rotating cone dryer is available in six sizes. Built to Stokes' high vacuum standards, they are especially suited for those materials which require the tumbling action and/or the charging and discharging features offered by this type of dryer.

Stokes conical-shaped dryers are double-walled, and include provisions for steam or hot water heating. The interior surfaces can be supplied in carbon steel or in 304 or 316 stainless steel for use with corrosive products. The large, full-opening charging inlet is provided with a quick-acting hinged cover. The discharge port features a self-wiping vacuum-tight valve, worm-gear actuated. Every drum is vacuum tested by mass spectrometer.

STANDARD SIZES
(special sizes and materials available)

Model No.	159-1	159-2	159-3	159-4	159-5	159-6
Working Cap.*	3	10	25	75	100	150
Approx. Wt.	1,750	2,400	3,200	7,700	11,500	12,700

**In cubic feet—normal working capacity is 65% of total volume*

Call on Stokes Engineering Advisory Service for complete information and application data on these and other Stokes vacuum dryers as applied to your own production requirements.

Vacuum Equipment Division
F. J. STOKES CORPORATION
5500 Tabor Road, Philadelphia 20, Pa.

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Consider all the money-saving aspects of a Sperry Filter Press. These include low initial cost . . . nominal installation . . . minimum maintenance . . . low depreciation . . . and an economy of operation that extends through many years of trouble-free performance.

However complex your filtration problems may be, these economies are basic to the solution.

You can avail your plant to the economies of a Sperry Filter Press, custom-engineered to meet your particular requirements for flow rate, cake build-up, washing, extraction, thickening, etc. Variations are provided, offering center, side or corner feed; open or closed delivery; simple or thorough washing; high or low temperature control. Plates may be had in aluminum, wood, iron, bronze, stainless steel, lead, rubber, nickel or any other special materials to meet your requirements. Any filter media can be used . . . cloth, synthetics, wire screen . . . paper. Labor-saving plate shifting devices and semi-automatic closing attachments are adaptable for any model . . . to increase production, minimize operation hazards and reduce wear and tear.

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CE-6

in the design, engineering or construction of an elemental phosphorus plant or any part thereof. This restriction, which applies even to evaluation of designs or data independently conceived or presented to him by a client or employer, virtually bars Miller for life from engineering practice in the field of phosphorus manufacture.

This court action in the Monsanto case certainly goes beyond the simple question of who owns the blueprints. Mr. Curtis, in his letter, does not dwell on the bigger question.

Finally, we accept as a signal compliment Mr. Curtis' impression that we are championing the rights of the individual engineer. Some business and professional publications are criticized by their readers as being mere mouthpieces for big corporations.—ED.

On Professional Worth

Sir:

An article in your Dec. 1 issue (pp. 127-128) dealt with government rulings concerning professional employees, particularly as these people are affected by the overtime provisions of the Fair Labor Standards Act.

The general staff consensus here at ACS headquarters laments the fact that any salary must be included in the definition of professional workers, particularly since the present provisions exclude doctors and lawyers.

DAVID A. H. ROETHEL
American Chemical Society
Washington, D. C.

Bare and Installed Costs

Sir:

In regard to "Bare vs. Installed Costs" (Oct. 20, pp. 214-215), we would like to have both —that is, the cost of equipment fob. or delivered *and* the cost of installation, separately. We have quite a lot of reliable data on the cost of equipment and materials, but very little on installation costs.

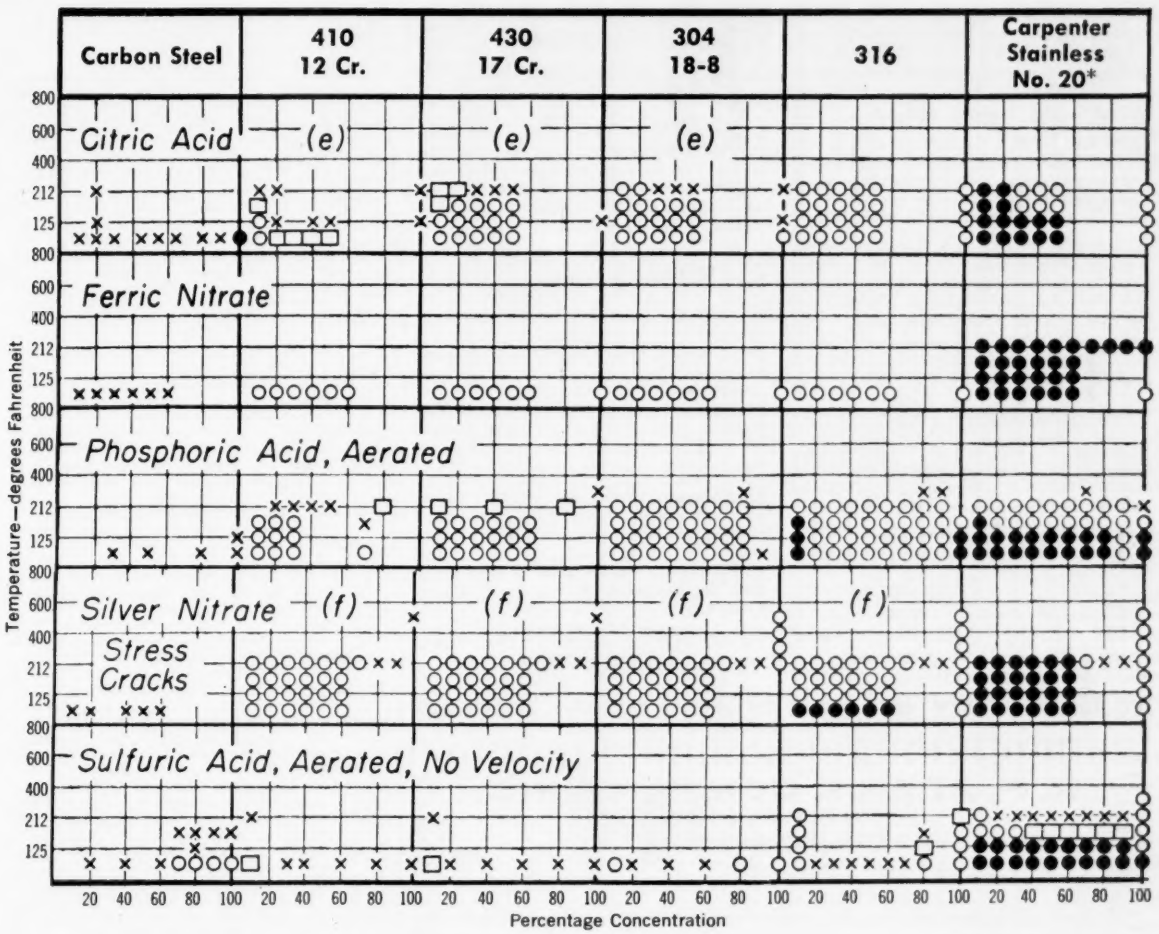
We find a great deal of useful cost information in *Chemical Engineering* and hope it will continue.

BENNETT FISHER
Dorr-Oliver Inc.
Stamford, Conn.

The best single answer to most corrosion problems—*Carpenter* Stainless No. 20*

Carpenter Stainless No. 20 is your lowest cost way to control the most severe corrosive conditions. It's available in sheet, plate, bar, forging billets, forgings, tubing and pipe through your local distributor. And Carpenter Stainless No. 20 simplifies inventory problems. You don't need duplicate stocks of other products . . . one stock of Carpenter Stainless No. 20 will put an end to most corrosion problems. Order now from the "House of Corrosion Control". Complete technical data and job performance reports are yours for the asking. Write on your company letterhead to The Carpenter Steel Company, Alloy Tube Division, Union, N. J.

available through representatives and distributors in over 40 cities . . . coast to coast



Key: ● Corrosion rate less than 2 m p y ✕ Corrosion rate greater than 50 m p y
○ Corrosion rate less than 20 m p y (e) Avoid chlorides
□ Corrosion rate from 20 to 50 m p y (f) Acid free

Corrosion data taken from Metals Handbook

an adams report

NO. 2 OF A SERIES

RECIRCULATION MAY BE KEY TO FUTURE GROWTH OF CHEMICAL AND INDUSTRIAL PROCESSES

How much water do you need to make: a ton of steel? a ton of synthetic rubber? a ton of bromine? a barrel of beer?

These are not empty questions. They point to a critical problem which confronts management today in its plans for tomorrow. It is more critical than most of us realize... for industry today uses as much water as all other users.

Industry's Needs in 1975

Water is vital for chemical and industrial growth. By 1975, industry will require 215 billions of gallons daily. That is a 100% increase over our current industrial consumption... more than we currently consume for all uses combined.

Competing for this water will be irrigation farmers and the general public. Their combined needs by 1975 will be up 40 billion gallons a day... possibly even more.

What is the Supply Picture

More than 40% of the communities in the United States already have a critical water supply problem. Yet, to meet the 1975 needs, our supply must be expanded by 50%, at an estimated cost of $50 billion.

Indications are that industry is going to have to bear its part of this cost. Certain communities are already moving to place flat water rates on all users... regardless of the volume used. Other groups are demanding a national water policy with full Federal Government regulation of natural sources.

Chemical Industry's Stake

Shortage of water can be a most serious threat to the expansion hopes of the chemical industry. A glance at the following table shows why. You need approximately:

20,800 tons of water per ton of	Bromine
2,500 " " " " " "	Synthetic rubber
830 " " " " " "	Viscose rayon
300 " " " " " "	Newsprint
208 " " " " " "	Smokeless powder
15 " " " " " "	Coke from coal

While process refinements may be able to reduce slightly the amount of water needed for each product, the gains will be minor.

Difference Between Use and Consumption

This is best illustrated by the water needed to make a ton of steel. The industrial average is 65,000 gallons (271 tons). In the past, 65,000 gallons of water flowed out of a river through the steel mill and back into the river again for each ton of steel made. In this case, use and consumption are one and the same thing.

On the west coast, a large steel mill now requires only 1,100 gallons of makeup for each ton of steel produced. This steel mill has its own recirculation system which holds several million gallons of water.

This water is recirculated at a rate equal to 65,000 gallons per ton of steel produced. The only water consumed is that lost due to evaporation or through leakage. Thus, net consumption has been reduced to 1,100 gallons.

Two Bulletins Available

One of the most important pieces of equipment in a recirculation system is a filter. Where high quality process water is needed, diatomite filters will provide an effluent second only to distilled water. Bulletin 651, released by the R. P. Adams Company, Inc., 507 E. Park Drive, Buffalo 17, N. Y., covers this type of industrial water filter.

A second publication, Bulletin 909, covers an Automatic Water Filter which is frequently used in recirculation systems where the water is used for less critical applications. This bulletin is also available on request from the R. P. Adams Company at the above address.

By the way, it takes almost two tons of water to brew a barrel of beer.

CONSERVE WATER, OUR MOST VALUABLE NATURAL RESOURCE

R. P. ADAMS COMPANY, INC.
507 E. PARK DRIVE
BUFFALO 17, NEW YORK

F-59

We have a problem involving liquid filtration. Ask your local representative to call on us.

Name _____ Title _____
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TECHNICAL

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Chemicals

Acetonitrile.....Detailed information on acetonitrile as an extractive distillation solvent along with information on azeotropic mixtures of acetonitrile is available.
121 *Union Carbide Chemicals Co.

Activated Carbons.....A complete line for every purpose; design & prefabricate complete purification, separation & recovery systems to meet your needs. Literature.
R210 *Barnebey-Cheney

Alkyds.....3 p. technical data sheet describes Cellolyn 604, a short-oil alkyd compatible with company's Parlon chlorinated rubber. Combination is for metal finishes.
202A Hercules Powder Co.

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63 *Kaiser Aluminum & Chemicals

Aromatics.....A Specifications File containing valuable information on high purity aromatics is now available on request. Facts on benzene, toluene & xylenes.
97 *Delhi-Taylor Oil Corp.

Borohydride.....Complete information MHI sodium borohydride & potassium borohydride is now available. Alcohols, Amines, etc. respond to borohydride treatment.
85 *Metal Hydrides Incorporated.

Butyl Rubber.....12 p. Bulletin 105-1 reports on a study of various antiozonants, antioxidants, sunproofing waxes and their possible improvement of butyl's ozone resistance.
202B Thiokol Chemical Corp.

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Cover *Shell Chemical Corp.

Chemicals, Organic.....4 p. listing of specifications covers company's dimer acid, azelaic acid, pelargonic, capric and caprylic acids, plasticizers, textile chemicals.
203A Emery Industries Inc.

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203B Dow Chemical Co.

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81 *The Quaker Oats Co., Chem. Dept.

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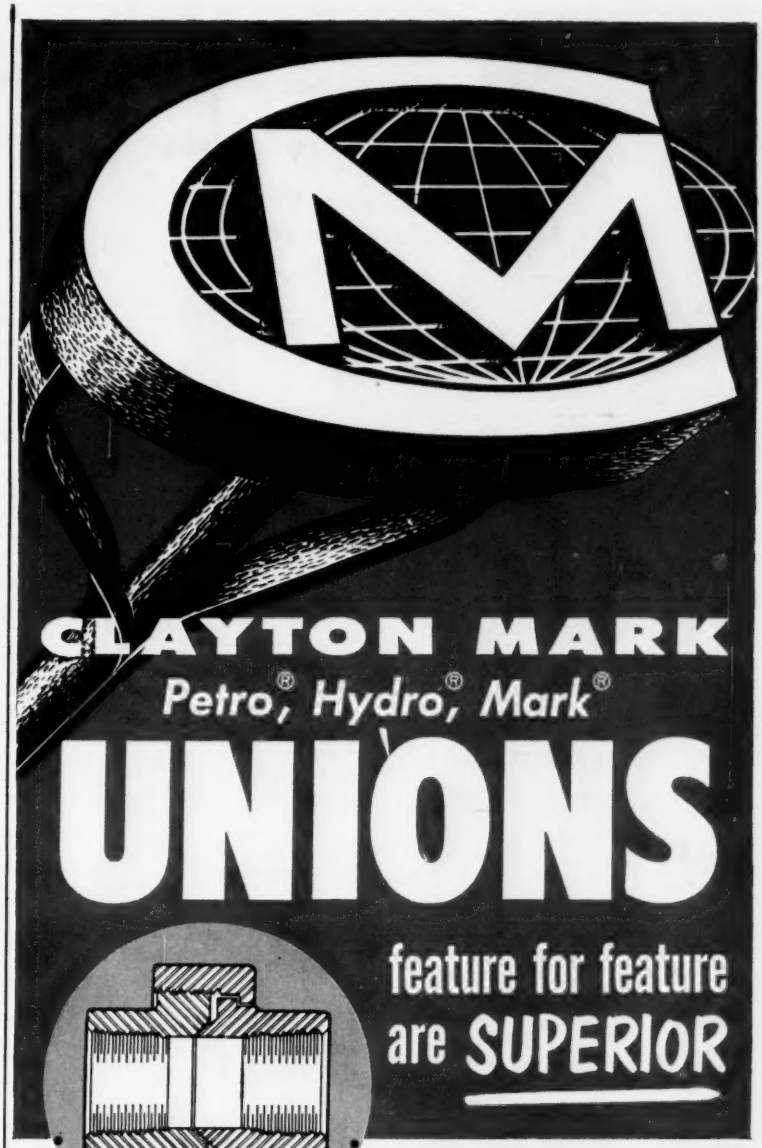

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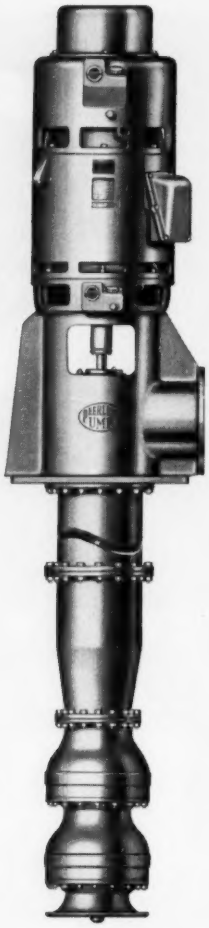

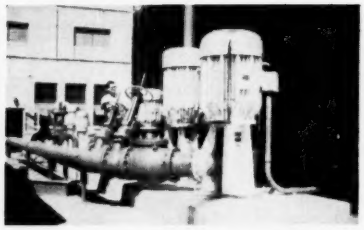

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1c	24-25a	47	69	92A	99-100c	109	161	184A	196	208F	212G	216A	222D	235a
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12	39b	52h	88C	98A	107c	151a	179	192	203A	L210	214E	R219d	226B	240d
13	39c	53	88D	98B	107d	151b	180	192A	203B	R210	R215	220	226C	240e
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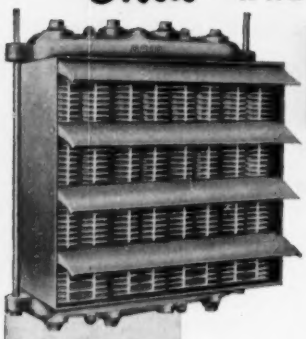

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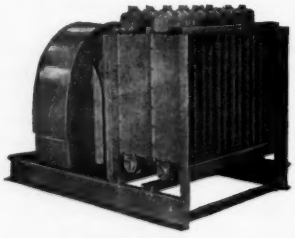

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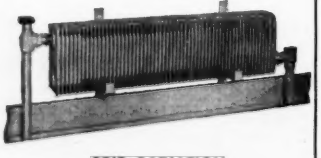

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Latex, Polystyrene.....4 p. bulletin describes Dow Latex 586, an improved polystyrene latex for various plastics and coatings uses. Details on physical properties, applications.
208A Dow Chemical Co.

Lubricants.....The Management Practices book is now available. This guide to organized lubrication discusses methods that help raise production, extend parts life.
163 *The Texas Company

Mineral Oil.....Bulletin 101 outlines application and test data on Atomol, highly refined white oil that resists clouding and discoloration in atomic shielding windows.
208B L. Sonneborn Sons, Inc.

Molybdenum Hexacarbonyl.....Three new bulletins describe properties of: molybdenum hexacarbonyl, tungsten hexacarbonyl, tungsten hexachloride.
208C Climax Molybdenum Co.

Nitrogen Tetroxide.....available in 125-cylinders or in tonnage quantities. Details on Nitrogen Tetroxide as a reactant & tech. assistance on your proposed application.
49 *Allied Chemical, Nitrogen Div.

Petrochemicals.....Complete information on Ethyl Acetate including specification sheets and product description bulletin is now available on request.
91 *Enjay Company, Inc.

Phenolic Resin.....5 p. service bulletin 305 describes a new heat-reactive phenolic resin, Durez 19428. Describes how it is used in neoprene cement solvents.
208D Durez Plastics Div.

Phosphoric Acid Safety Data Sheet.....Properties & safe-handling practices have been compiled in a 14-page reference booklet. Covers fire fighting, employee safety, etc.
99-100c *U. S. Industrial Chem. Co.

Platinum Catalysts.....Highest levels of purity in production of high-purity chemicals, vitamins & biotics. World's largest facilities at your service. Brochure.
8-9c *Engelhard Industries, Chem. Div.

Polyester Molding Compound.....4 p. folder furnishes technical information on Thermaflow 105, a new glass-reinforced polyester molding compound.
208E Atlas Powder Co.

Polyethylene in Radioisotope Labs..... Polyethylene's properties of radiation-resistance, chemical inertness & physical toughness are proving invaluable in Radioisotope Labs.
99-100b *U. S. Industrial Chem. Co.

Polyurethane Elastomer.....24 p. booklet describes Disogrin, company's polyurethane elastomer. Includes physical, chemical, electrical, other technical data.
208F Disogrin Industries, Inc.

Protective Coatings.....4 p. Bulletin 100 simplifies selection of coatings according to service requirements. Corrosive conditions are broken down into 4 classifications.
208G Carboline Co.

Resins.....Series of 4 p. folders describes the physical properties of 54 grades of resin now in commercial use in the manufacture of adhesives.
208H Shawinigan Resins Corp.

* From advertisement, this issue

Silicone Intermediates.....12 p. data sheet describes four silicone intermediates sold as liquids: XR-820, XR-322, XR-830 and A-183. They improve plastics' resistance.
209A Union Carbide Corp.

Silicone Rubber.....Room temperature vulcanizing silicone rubber is described in CDS 170. Compound is for electrical potting and encapsulating.
209B General Electric Co.

Sodium Coolant.....A study is being made to investigate the technical feasibility of using the radioactive sodium coolant for industrial radiation processing.
99-100f *U. S. Industrial Chem. Co.

Sodium Dispersions.....New products & processes possible through development of finely-divided sodium techniques. Details on syntheses possible with organosodium.
99-100a *U. S. Industrial Chem. Co.

Urethanes.....3 p. bulletin TIB No. 13-F5 describes a spot test for differentiating polyester from polyether based urethane polymers. Test takes one minute.
209C Mobay Chemical Co.

Zein.....20 p. booklet "Zein—A Versatile Protein for Industry" gives examples of industrial applications of company's Argo Grand Zein G200.
209D Corn Products Sales Co.

Zirconium Valve Stems.....prove ideal for acid service. Valves used in all concentrations of hydrochloric & sulfuric acids, raffinate, acidified hexone, etc.
99-100d *U. S. Industrial Chem. Co.

Construction Materials

Alloys, Nickel & Monel.....Booklet "The Resistance of Nickels and Its Alloys to Caustic Alkalies" gives complete technical data & service records.
120 *International Nickel Co.

Anode Hook.....The titanium anode hook offers important advantages in highly corrosive plating applications. Technical Data Sheet & application information available.
46 *Mallory-Sharon Metals Corp.

Cast Alloys.....Chart contains 55 of the more widely used cast alloys in the carbon, low alloy and stainless steel groups; also nickel and monel. Composition, properties.
209E Lebanon Steel Foundry

Castings.....A complete brochure, "Foundry Work-Steels, Alloys and Non-Ferrous" is now available. Producers of CF4 stainless steel castings.
R215 *Service Foundry Div., Avondale

Coating, Tape.....Polyken protective tape coating...elastic, inert, nondrying...offering stable protection under the most severe chemical conditions.
179 *The Kendall Company

Coatings, Protective.....Niphos is a corrosion-resistant protective coating for all mild steel. The advantages & applications of Niphos are outlined in a brochure.
209F Tube Reducing Corp.

* From advertisement, this issue

PROPANE-AIR MIXING SYSTEMS
Custom-Engineered for Standby Use

Principal Components of Eclipse Standby System

1. Consta-Mix Valve
2. Gas Booster
3. Zero Governor
4. Locktite Safety Valve
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Eclipse Consta-Mix proportioning valve and gas booster are the heart of every packaged standby system.

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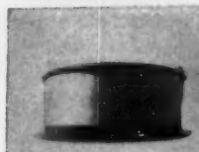
EXPORT: Ad. Auriema, Inc., 85 Broad St., New York 4, N.Y.

Eclipse **INDUSTRIAL COMBUSTION DIVISION**



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PROVO, UTAH • CASPER, WYO.
BIRMINGHAM, ALA.

Sales offices throughout the U.S.A.

LITERATURE . . .

Corrosion Data.....New 40-page booklet gives many charts and graphs that show penetration rates for the manufacturer's alloys in over 250 different corrosives.
210A Haynes Stellite Co.

Fabricating.....Any type & size of plate work including heavy wall pressure vessels for the petroleum, chemical, paper & other industries. Booklet describes facilities.
22-23 *U. S. Steel, Amer. Bridge Div.

Filter Aids.....Celite, the diatomite filter aid with a wide range of grades. Features fast flow rates plus lower wet density. Covers more filter surface per lb. Details.
30-31 *Johns-Manville

Gaskets.....Folder AD-104 outlines the spiral wound guardian gaskets for high temperatures & pressures against steam, oils, gases, liquids, etc. For pressures to 2500 psi.
109 *The Garlock Packing Co.

Insulation.....Calsilite is a molded calcium silicate insulation that absorbs moisture without disintegration & dries out without loss of efficiency. Details.
L223 *The Rubberoid Co.

Lead.....is one of the most efficient & economical protection materials against many acids. The Lead Handbook for the chemical process industries is offered. Bul. 162.
181 *Federated Metals Div. of ASARCO

Nickel Copper Alloy.....Complete technical data and service records are available. Also, "The Resistance of Nickel and Its Alloys to Caustic Alkalies."
175 *The International Nickel Co., Inc.

Refractories.....There is a wide range of products, each with a combination of properties. A copy of "Super Refractories by Carborundum" is now available.
18 *The Carborundum Co.

Stainless Steel.....Stainless No. 20 is available in sheet, plate, bar, forging billets, forgings, tubing & pipe. Complete technical data & job performance reports offered.
201 *The Carpenter Steel Co.

Synthetic Rubbers.....“Elastomers in “Industry” gives information about the properties & many industrial uses of neoprene and Hypalon. The right product for your application.
165 *E. I. du Pont de Nemours & Co.

Wire Cloth & Screen.....resists distortion, corrosion, heat & pressure. Condensed Screen Reference Catalog gives specifications and other details.
190 *Ludlow-Saylor Wire Cloth Co.

Electrical & Mechanical

Couplings.....Bulletin QSR 58 describes an extensive line of Quick-Seal couplings for hydraulic and pneumatic applications. Flow data and pressure data included.
210B Titeflex Inc.

Drives, Poly-V.....feature a single unit, V-ribbed belt. Bulletin M141 gives complete information on Poly-V Belts to meet every heavy duty power requirement.
118 *Raybestos-Manhattan, Inc.

* From advertisement, this issue

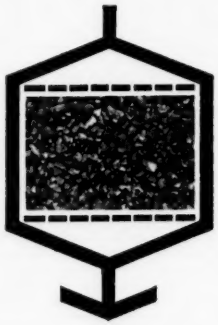
how to keep a guppy happy

Your pet fish—or your friends downstream will breathe easier and longer if activated charcoal keeps the water pure. Reducing stream pollution can often pay its way in profitable recovery of waste products, in better public relations. Well worth looking into.

how to smell no evil

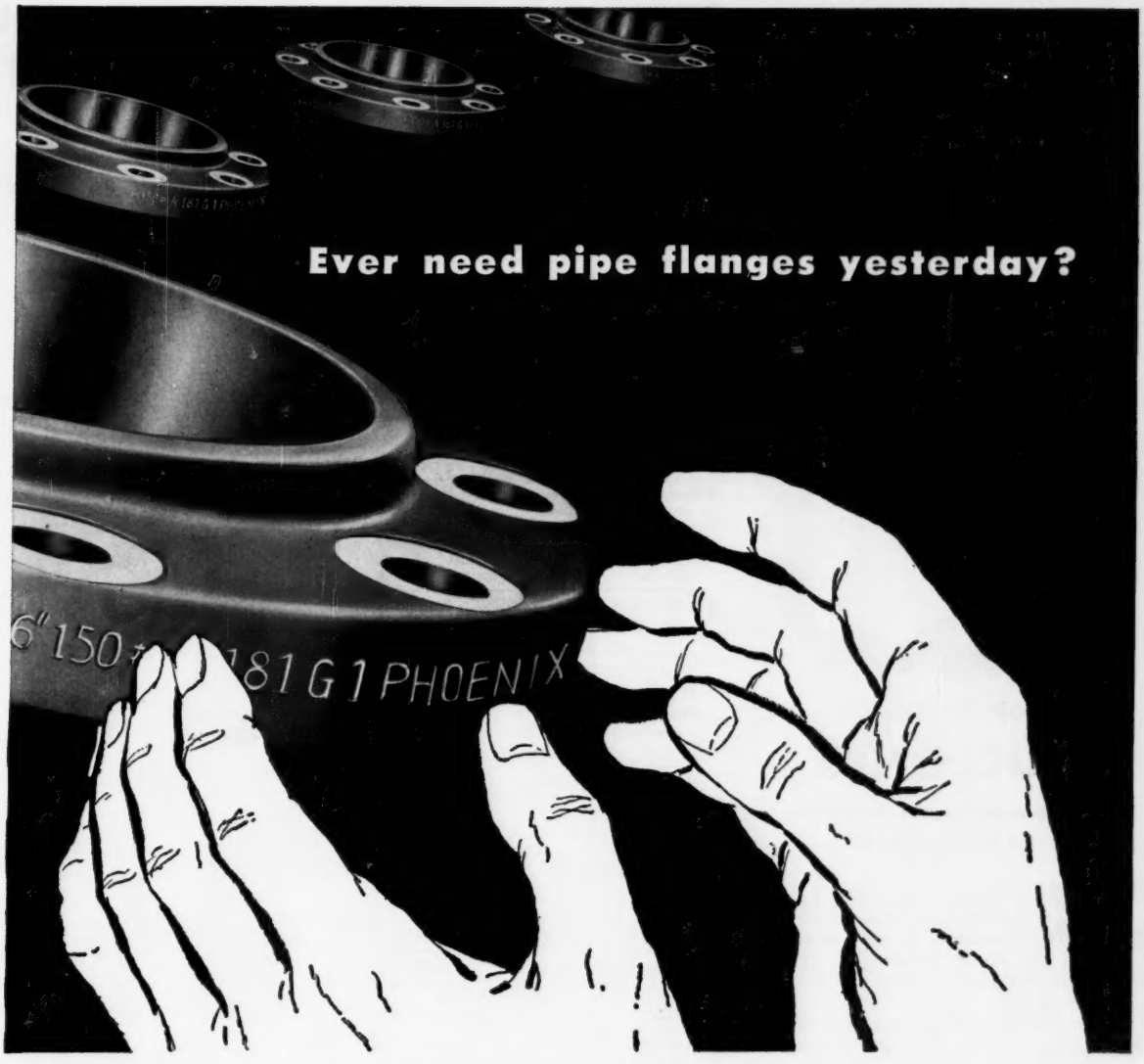
Some people wear gas masks (containing activated charcoal). Others breathe air freshened with activated charcoal air purifiers. They (the people) work better, more safely. You save money by recirculating warmed or cooled air instead of blowing it away. Suggest you ask your plant or consulting engineers about it.

activated carbon



We supply a complete line of activated carbons for every purpose; design and prefabricate complete purification, separation, and recovery systems to meet your particular needs. Write for literature and recommendations on your specific application. Barnebey-Cheney, Columbus 19, Ohio.

Barnebey Cheney



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DUCLONES®

assure maximum recovery at lowest cost

DUCLONES–Ducon high efficiency cyclones–are designed and constructed for high recovery efficiency and low gas resistance. Their sturdy construction assures long, continuous service with a minimum of maintenance.

The exceptional performance of Duclone collectors is the result of these 6 unique features:

1. **Small Diameter produces high efficiency**
2. **Helical Roof provides a turbulence-free path for the entering gas stream**
3. **Steep Cone improves dust separation**
4. **Dust Trap assures efficient dust removal from the cone**
5. **Vortex Shield prevents re-entrainment of dust in upward gas vortex**
6. **Scroll Outlet provides a low resistance clean gas outlet**

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THE **Ducon** COMPANY, Inc.

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LITERATURE . . .

Electric Motors.....A new 16-page catalog covers a wide range of practical information on how to get the most from your electric motors. Send for your copy.
TL237 *Revco Incorporated

Enclosure, Spin Top.....Bulletin 9990 gives details on enclosures for reversing & non-reversing across-the-line starters & combination starters.
45 *Square D Company

Gears.....High-performance, precision gears from less than one in. to over 200 in. in diameter and with tooth-to-tooth accuracies of 0.0002 in. are topic of Bulletin 6430.
212A General Electric

Lighting Fixtures.....New explosion-proof Mercury Vapor lighting fixtures offer security in hazardous locations. Catalog sheet outlines all the features.
56 *Crouse-Hinds Co.

Motor.....Super Seal motor design is completely unaffected by moisture, dust, dirt, oil, acids & alkalies. Available in any integral horsepower size. Data available.
35-38 *Allis Chalmer Mfg. Co.

Transformers.....Catalog contains complete information on manufacturer's line of dry and liquid-filled transformers. Valuable data, drawings and photographs.
212B Marcus Transformer Co.

Turbines, Solid-Wheel.....feature a single-piece wheel which is virtually indestructible. Range in capacity from 50 to 240 HP. Details in bulletin S-116.
40 *The Terry Steam Turbine Co.

Handling & Packaging

Conveyors.....New handbook is available as a reference book for engineers using conveyors to solve unit load handling problems. Deals with roller gravity conveyors.
212C Lamson Corp.

Conveyors, Vertical.....Bulletin 205 describes the Combing vertical conveyor, which is a method of tying horizontal floor conveyors on several floors together.
212D Lamson Corp.

Lifter.....Bulletin describes crane-suspended vacuum lifters for lifting and moving steel and nonferrous plates. Unit has maximum of 8,000 lb. lifting power.
212E F. J. Littell Machine Co.

Tanks.....for transferring radioactive process wastes. Designed in stainless for its ability to withstand either basic or acidic liquid wastes without serious corrosion.
212F *Graver Tank & Mfg. Co., Inc.

Pallet Truck.....Bulletin 587 gives complete engineering data and specifications on features of the all-new Model PXG electric pallet lo-lift truck. Lift is 4 in.
212G Barrett-Cravens Co.

Stackers.....Complete specifications and operating characteristics and advantages of four high-lift, battery-powered hand trucks are the topic of a new brochure.
212H Clark Equipment Co.

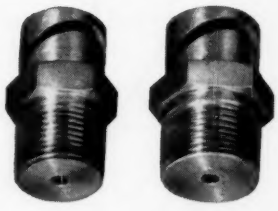
* From advertisement, this issue

GET MORE OUT OF YOUR SPRAYING EQUIPMENT WITH LESS POWER

For spraying, washing, rinsing and cooling, Yarway Spray Nozzles will improve the efficiency of your spray equipment.

There are no internal vanes or other restrictions to clog or hinder the flow.

Cast bronze Involute-type
(Bar stock also available)



Bar stock Fan-spray-type

Yarway Spray Nozzles are available in two types—the Yarway Involute producing fine hollow cone spray with minimum energy loss, and the Yarway Fan-spray for flat fan-shaped spray with time-saving slicing action for cleaning.

Ask for a free copy—Bulletin N-618.

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LITERATURE . . .

Air Hoists.....Offer fire-safe, non-sparking operation; they provide a positive, steady lift; they possess every feature for easy safe load spotting. Bul. 86-1.
195 *Gardner-Denver Co.

Drums.....Alloy metal, stainless steel, & nickel & monel drums are featured. Offer protection against product discoloration, chemical changes & corrosive action. Details.
13 *Pressed Steel Tank Co.

Pulleys.....Belt Saver Pulleys can extend the life of your conveyor belts or bucket elevators & minimize your shut-down & maintenance costs. Handle sand, asbestos, etc.
48 *Sprout-Waldron

Tanks.....of carbon & stainless steel for chemical storage. Also pressure vessels & processing equip. of aluminum & special alloys. Booklet "Tank Talks" is offered.
B224 *R. D. Cole Mfg. Co.

Heating & Cooling

Coolers, Closed Circuit.....Evaporative type closed circuit coolers for cooling fluids, condense gases, & dissipate waste heat. Modulating controls available.
39a *Marlo Coil Co.

Cooling Towers.....are suitable for indoor or outdoor installation. Compact in design, quiet operating. All metal construction. Additional information available.
39b *Marlo Coil Co.

Finned Heat Transfer Surfaces..... are now available in stainless steel alloys. Also available in any combination of commercial metals and alloys. Details.
39c *Marlo Coil Co.

Heating Equipment.....The complete story on Grid unit heaters, blast heats, & Grid radiation for chemical use are contained in catalog No. 956.
208 *D. J. Murray Mfg. Co.

Heat Exchangers.....Brazed Aluminum heat exchange equipment is lightweight, compact-packs 450 sq. ft. of heat exchange surface in 1 cu. ft. Information available.
10-11 *The Trane Co.

Heaters, Dielectric.....Features include: clean wiring arrangements, bakelite standoff, ceramic coils, sturdy relays. Complete details in Bulletin 15B6431C.
108 *Allis-Chalmers

Heaters, Oil.....Fuel oil heaters for use on the suction side of pumps—for heating extremely viscous fluids—is the topic of a new bulletin. Finned-tube data.
213A Brown Fintube Co.

Preheater.....For details on air preheaters and information on potential fuel economy, a factual article is available. Slagging is reduced & cuts boiler downtime.
105 *The Air Preheater Corp.

Thermo-Panels.....for the utmost in drum warming or cooling modern chemicals. Complete data & costs on thermo-panel drum warmer or cooler in Form DW-6-1.
TL216 *Dean Products Inc.

* From advertisement, this issue

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ROTATES WITH THE SHAFT

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MEANS RELIABILITY IN MECHANICAL SEALING

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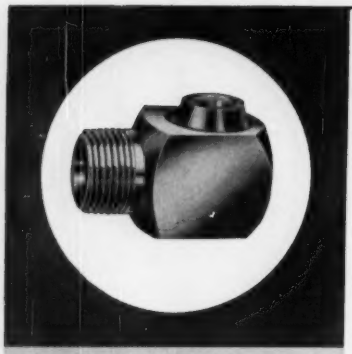

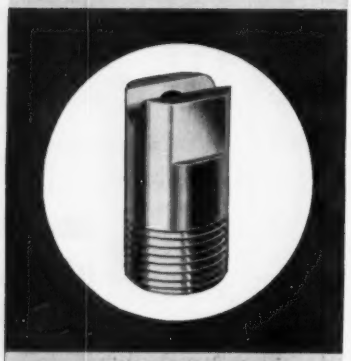

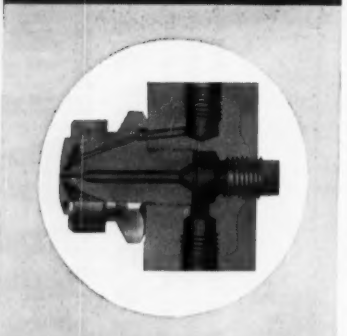

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to meet every particular spraying need

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SPRAYING SYSTEMS CO. THEORETICAL AND APPLIED RESEARCH LABORATORY

LITERATURE . . .

Instruments & Controls

Control.....The Airtrol automatic process control responds to a 3 to 15 p.s.i. pneumatic signal & is adaptable to all standard process instrumentation. Data Sheets offered.
12 *Reeves Pulley Co.

Control System.....The AccuRay continuous process analyzer & level control system senses density & level independent of other product characteristics.
178 *Industrial Nucleonics Corp.

Data Processing Equipment.....New brochure describes the functions of Univac data processing equipment and illustrates broad range of functions.
214A Remington Rand

Electronic Instruments.....Bulletin P1245-A gives complete specifications of manufacturer's potentiometer and bridge instruments. Also sensing elements, accessories.
214B Bristol Co.

Gage, Magnetic.....for liquid level observation. Safety design seals against escaping gases. Available with electric alarms. Engineering sheet is offered.
R225 *Jerguson Gage & Valve Co.

Instruments, Pneumatic.....Tel-O-Set miniature instruments accurately record, indicate, & control process variables. For complete information, Catalog C 100-1a.
14-15 *Minneapolis-Honeywell

Pressure Regulators.....Illustrated booklet contains flow and pressure specifications, as well as inlet and outlet dimensions, for each regulator of complete line.
214C Air Reduction Sales Co.

Spectrophotometers.....Performance and versatility of DK Double-Beam Ratio Recording Spectrophotometers are illustrated in new brochure.
214D Beckman

Stream Analyzers.....Bulletins on this topic include information on nuclear instrumentation chromatographs, mass spectrometers and sample-handling accessories.
214E Consolidated Electrodynamics

Tank Level Detector-Controller.....The AccuRay can be used either horizontally or vertically. Accuracies can be maintained to plus or minus 1/16".
41 *Industrial Nucleonics Corp.

Pipe, Fittings, Valves

Connectors, Flexible.....MNH flexible connectors dampen vibration, permit offset movement, absorb expansion, etc. Fact-filled Alliflex Engineering Data Sheet offered.
TL227 *Allied Metal Hose Co.

Expansion Joints.....The Expansion Joint Design Guide features 28 pages of valuable information on expansion compensators, flexible connectors, etc.
93 *Flexonics Corp.

* From advertisement, this issue

MATERIALS FOR NUCLEAR REACTORS

JUST PUBLISHED—A systematic treatment of the atomic fuel cycle and of the preparation, properties, and behavior of the important materials in reactors. Describes the beneficiation, purification, and conversion to metal or oxide of uranium and thorium ores, and their fabrication into fuel elements. Testing and evaluation, stability or instability of the fuel to irradiation, and chemical processing of the spent fuel also are clearly treated. **Edited by Bernard Kopelman, Sylvania-Corning Nuclear Corp. 411 pp., illus., $12.00.**

COATED ABRASIVES
Modern Tool of Industry

Here is an authoritative guide to the nature, advantages, and efficient use of coated abrasives. Describes applications in metalworking, woodworking, glass, and plastics industries. Specific directions on new uses, plus special materials on cutting oils, lubricants, coolants, etc. **Prepared by Coated Abrasives Manufacturers' Institute. 452 pp., 546 illus., $8.50**

ELEMENTARY CHEMICAL ENGINEERING

A simply-written guide giving you broad over-all knowledge of chemical engineering that you need and use every day. Step by step, you are taken through basic chemical engineering unit operations—flow of fluids, heat transfer, evaporation, distillation, filtration etc. Production of sulfuric acid, fuel and industrial gases and electrolytic processes and nuclear reactions are described in basic terms. Includes details on piping, valves, fittings, pumps, steam traps, conveyors, evaporators, packings and driers, etc. **By M. S. Peters, Univ. of Illinois, 322 pp., 65 illus., $6.75**

HOW TO BECOME A PROFESSIONAL ENGINEER

Shows how to get your professional engineer's license more easily – how to apply, how to take oral and written exams, how to write experience record, etc. Explains state laws, how examiners evaluate experience, examination room procedure, and other practical aids. Applicable in all states. By John D. Constance. 262 pp., $5.50.

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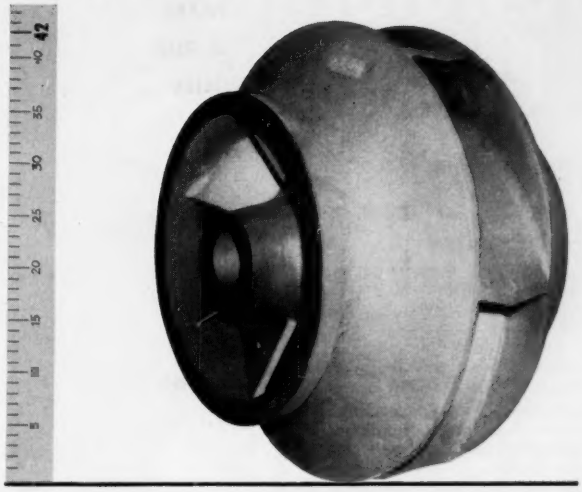

CF4(304L) Stainless Steel Pump Impeller, 42 inches in diameter and weighing 2300 pounds.

AND STAINLESS STEEL

Throughout a wide range of foundry products, Service Foundry has earned its fame in stainless steel castings. One such product, a pump impeller, is shown above. But Service makes many large stainless steel castings for the chemical industry . . . in fact, *Service Foundry is the largest producer of CF4 castings in the United States.* This should mean something to you . . . as does the fact that Service Foundry regularly pours castings up to 10,000 pounds. *Capacity* . . . to handle the big jobs—*experience* . . . to handle them well. Yes, when your next order bears the Service Foundry name—you can be sure you're getting the very best in cast steel products.

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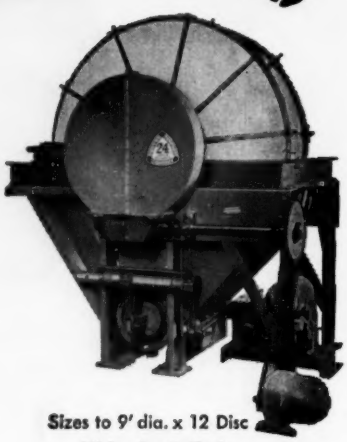

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DENVER Spiral Rake Thickeners
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DENVER Drum Filters
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DENVER Dryers
Sizes to 8' x 60' and larger
Write for Bulletin No. D4-B4

DENVER Steel Head Mills
Sizes to 10' dia. x 20' long
Write for Bulletin No. B2-B20

DENVER Automatic Samplers
8" to 120" Cutter Travel
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LITERATURE . . .

Nozzles.....Catalog gives complete details on lightweight, precision built steel spray nozzles. There is a Spraco model for every problem & application.
222 *Spray Engineering Co.

Nozzles, Spray.....to control liquid particle size & field distribution with accuracy. Offered in a wide range of types & capacities. Complete information in Catalog 24.
214 *Spraying Systems Co.

Nozzles, Spray.....for spraying, washing, rinsing & cooling. Available in two-types, Yarway Involute or Yarway Fan-spray. More information in Bulletin N-618.
R212 *Yarnall-Waring Co.

Pipe Clamp.....The emergency pipe clamp & pipe line clamp for repairing corrosion leaks & splits in pipe lines. Tremendously strong. Details in Folder.
69 *M. B. Skinner Co.

Pipe, PVC.....comes in sizes from ½ inch to 14 inches in diameter, & in schedules A, 40, 80 & 120. It does not contaminate sensitive solutions. Bulletin No. 24.
104 *U. S. Steel, National Tube Div.

Plastic Piping.....Made of rigid Koroseal polyvinyl chloride, line of piping, fittings and valves are ideal for many CPI applications. Described in Catalog 10050-A.
216A B. F. Goodrich

Rupture Discs.....Corrosion-resistant rupture discs offer dependable instant & automatic relief of excess pressure. Literature available.
8-9b *Engelhard Indust., Baker Platinum

Swivel Joints.....DS series swivel joints are recommended for chemical services ranging from −40° to +400° F & 300 psi. Bulletin 1258 for complete details.
20-21 *Chiksan Co.

Tubing.....Condenser tube in a wide range of sizes & alloys. Truflin type S/T is specifically engineered for use in shell & tube heat exchangers & condensers. Catalog.
185-188 *Calumet & Hecla, Wolverine Div.

Unions.....offer the widest application in high pressure-high temperature piping. Booklet "What makes a good union?" is now available.
203 *Clayton Mark & Co.

Unions.....These unions have four different seats for every general piping requirement...each completely interchangeable. Complete information inculding prices.
111 *Rockwood Sprinkler Co.

Valve, Gate Plug.....The No. 66 Gate valve is ideal for instrument lines, in small line handling viscous liquids or where a low pressure drop is important. Facts.
239b *Alloy Steel Products Co.

Valve, Needle.....The No. 62 Needle valve is particularly suitable for sensitive control of flow...as in metering or sampling for process plant, etc. Facts.
239a *Alloy Steel Products Co.

Valve, Stainless Steel.....models with Thermon jacket are designed for use in hot or cold service. Details on Thermonized valves in engineering data folder.
106 *Cooper Alloy Corp.

* From advertisement, this issue

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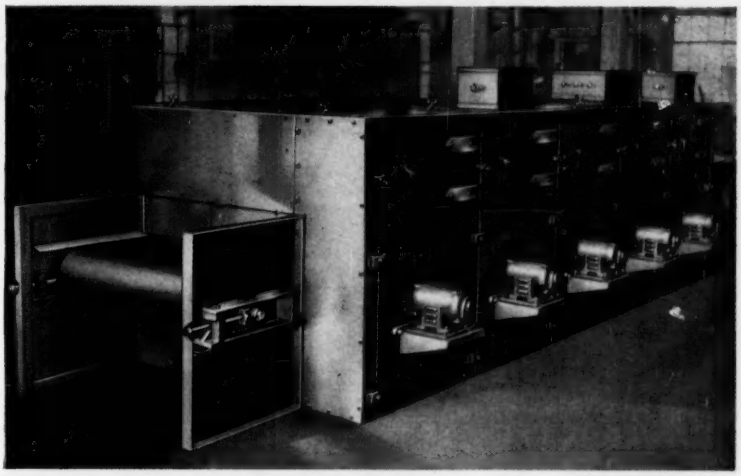

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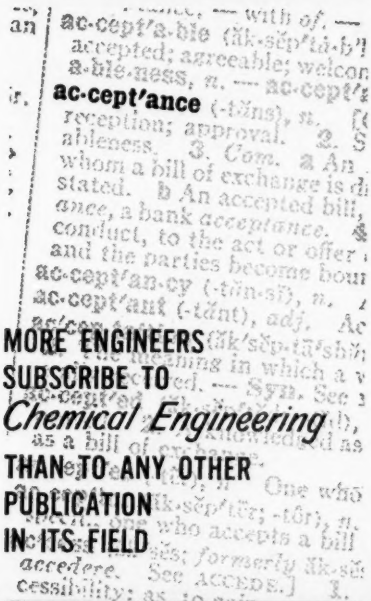

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LITERATURE . . .

Valves.....Solenoid valves are available in 2-way, 3-way or 4-way types. A wide range of body materials including cast iron, brass, bronze & stainless steel. Catalog 202.
43 *Automatic Switch Co.

Valves.....Bulletin E-16 discusses types, typical services, construction and operating features of line of valves for general services. Photos and cutaways.
218A Everlasting Valve Co.

Valves, Ball.....feature two sealing surfaces & handle wide range of liquids & gases. They are easily adapted for remote control devices. Literature available.
182 *Jamesbury Corp.

Valves, Plug.....Lubricated plug-valves are available in a complete range of sizes & pressure ratings to answer every flow control need. Complete details available.
19 *Rockwell Mfg. Co.

Process Equipment

Automatic Samplers.....with 8" to 120" Cutter Travel are described in Bulletin No. S1-B4. They are part of a complete line of size reduction equipment available.
216f *Denver Equipment Co.

Blenders.....Specialized information & complete data in Bulletin No. 16, Chemical Process Equipment and Bulletin No. 15A-1, Twin-Shell Laboratory Blenders.
58-59 *Patterson-Kelley Co.

Centrifugals.....features no crystal degradation. All cycle components are pneumatically operated. Full information contained in Bulletin No. 2775.
R223 *The Western States Mach. Co.

Dryer.....Information on automatic, semi-automatic or simple, manually operated units is contained in Bulletin D-102. A model & capacity to meet your needs.
67 *The C. M. Kemp Mfg. Co.

Dryers.....Denver Dryers for the Chemical Process Industries are described in Bulletin No. D4-B4. Sizes to 8' x 60' and larger are available.
216d *Denver Equipment Co.

Dryers, Agitated.....Complete data regarding horizontal dryers is contained in a 4-page illustrated technical Bulletin #301. Agitators designed for high discharge rate.
189 *Bethlehem Foundry & Mach. Co.

Dryers, Rotating Vacuum.....This rotating cone dryer is available in six sizes. Dryers are double-walled & include provisions for steam or hot water heating. Data.
199 *F. J. Stokes Corp.

Dust Collector.....The Cloth Bag Collector offers maximum efficiency for dust control. Bulletin 922 outlines dust control & blast cleaning equipment.
101 *Pangborn Corp.

Dust Collectors.....Miniature cyclone tubes, cast of white iron, provide ultra-hard, cling-free, self-cleaning surface for maximum material recovery. Bul. D-584.
BL225 *Dustex Corp.

* From advertisement, this issue

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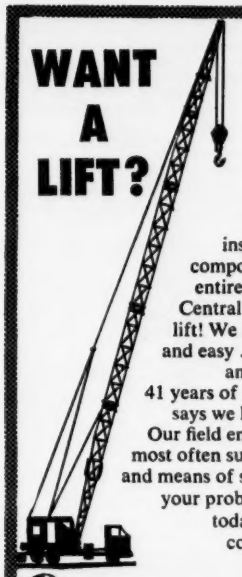

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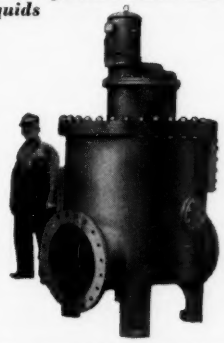

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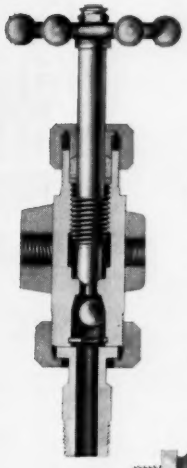

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especially designed for small batch processes

offer . . . precise mixing results with long term cost savings

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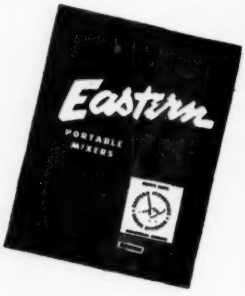
NEW PORTABLE MIXER BULLETIN

Eastern's improved line is included in the revised Portable Bulletin No. 530-B.



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MIXER DIVISION
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LITERATURE . . .

Dust Control.....Duclones cyclones are designed & constructed for high recovery efficiency & low gas re-restance. Offer 6 unique features. Bulletin C-958.
L212 *The Ducon Co.

Feeders, Airlock.....available in standard duty, heavy duty, & blow-thru types. Booklet P-58, "How to Select A Rotary Airlock Feeder", is offered.
BL227 *Prater Pulverizer Co.

Filter, Automatic Water.....which is frequently used in recirculation systems where the water is used for less critical applications. Details in Bulletin 909.
202b *R. P. Adams Company, Inc.

Filter, Drum.....These filters are described in Bulletin No. FG-B1. Sizes to 6' diameter x 8' long. Complete information on this type for every requirement.
216c *Denver Equipment Co.

Filter, Industrial Water.....Bul. 651 outlines diatomite filters. They provide an effluent second only to distilled water. They are important in a recirculation system.
202a *R. P. Adams Company, Inc.

Filter, Vertical Plate.....is particularly suited for toxic & volatile products. Availalbe in capacities from 100 square feet to 1000 square feet.
42 *Sparkler Mfg. Co.

Filters.....Bulletin EF/2 features Wet & Dry Cake Discharge Design charts & complete illustrations of the Filtration Cycle of vertical pressure filters.
220A The Duriron Company, Inc.

Filters.....Catalog, up-to-date fully illustrated reference manual of erection, operating, design & construction data & specifications is available.
200 *D. R. Sperry & Co.

Filters Disc.....The Agitator-type disc filters are available in sizes to 9" diameter x 12 disc. Bulletin No. F9-B5 gives full particulars on this type.
216a *Denver Equipment Co.

Gas Scrubbers.....A new brochure giving complete data on Chemico venturi gas scrubbers is available. Their simple construction permits wide application.
4 *Chemical Construction Corp.

Grinding Mill.....The Jet-o-mizer grinds to the narrowest classification over the broadest range of particle sizes. New bulletin describes them & also "Jet-o-clones."
167 *Fluid Energy Processing & Equip.

Mills, Impact.....available in sizes to meet individual requirements. A new bulletin tells most efficient methed of achieving particle size reduction by centrifugal force.
220B Safety Industries, Entoleter Div.

Mixers.....You'll find a wealth of information on fluid mixing in bulletins describing Lightnin Mixers. A condensed catalog shows all types. No. B-109.
240 *Mixing Equipment Co., Inc.

Mixers.....Six standard models available in 1 to 200 H.P. Special units up to 500 H.P. Feature horizontal motor or vertical motor drive. Catalog A-27.
47 *Philadelphia Gear Corp.

* From advertisement, this issue

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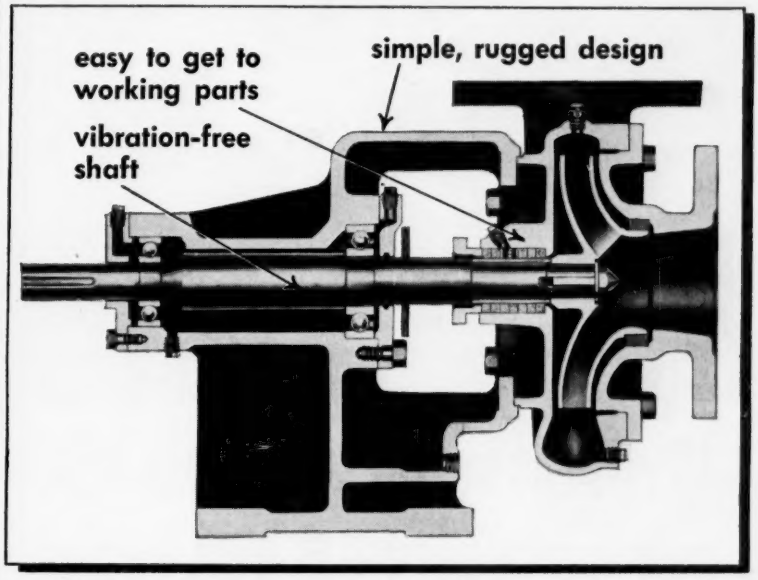

● Note, in the cut-a-way illustration above, the simplified, yet sturdy design of Weinman single-stage, end-suction pumps. The key to their low initial cost and efficient operation with little or no maintenance is the rugged, one-piece power frame combined with a neat, shipshape working head. This assures plenty of pumping power and long, trouble-free service.

Impeller, stuffing box and sealed shaft bearings are easy to get to for routine maintenance and service. This keeps down time at the lowest practical minimum.

Notice, too, in the illustration above, the compact design of Weinman end-suction pumps. The result is less shaft overhang. This, and the fact that precision-machined and finished Weinman pump shafts are mounted in two oversized sealed bearings are two important reasons Weinman pump shafts are deflection and vibration-free.

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WEINMAN single-stage, end-suction pumps are available in capacities from 10 to 2000 gpm.

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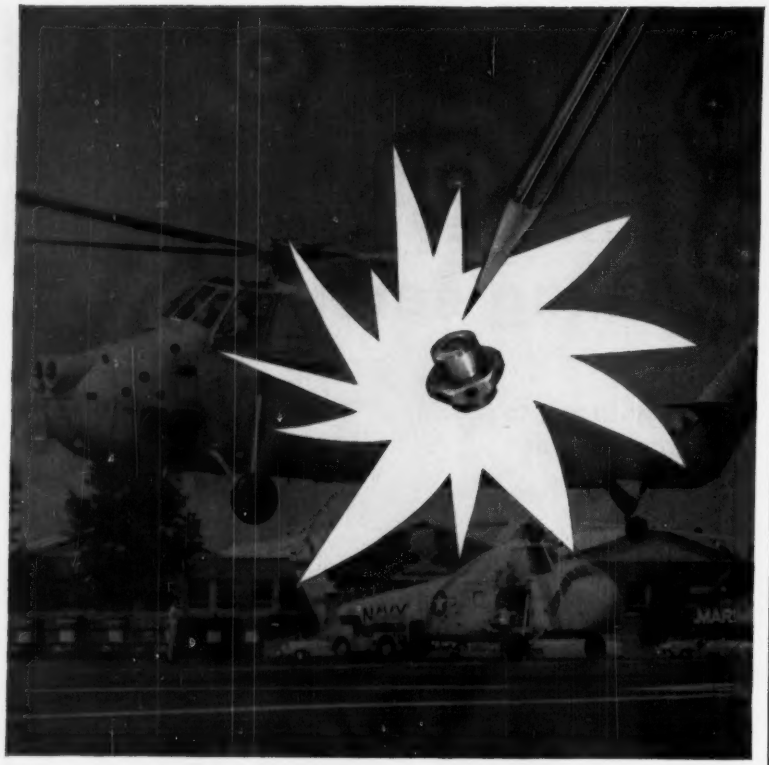

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At the heart of General Electric's new T58 turboshaft engine — a revolutionary new power plant for helicopters that packs over 1,000 horsepower into a 59″ long, 16″ diameter, 325 pound frame — are 16 precision built steel spray nozzles.

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LITERATURE . . .

Mixers, Centrifugal.....New principle of high speed mixing producing intimate dispersion. Available in all sizes to meet individual requirements. Bulletin.
222A Safety Industries, Entoleter Div.

Mixers, Portable.....Especially designed for small batch processes. Eastern's improved line is included in the revised portable bulletin 530-B.
220 *Eastern Industries, Inc.

Mills, Steel Head ..... Bulletin No. B2-B20 offers complete information on steel head mills available in sizes up to 10′ diameter x 20′ long, for your needs.
216e *Denver Equipment Co.

Mill, Disc-Roll.....incorporates pneumatic roll-loading. The problem of over-loading is eliminated. The mill is applied to dry grinding of minerals. Bul. 52-11.
196 *Hardinge Co., Inc.

Pilot Plant Dryer.....Uses gas, electricity or steam for heating element. Fully instrumented, has all necessary controls & recording charts. Details.
R217 *C. G. Sargent's Sons Corp.

Processing Equipment.....The authoritative new color booklet of performance reports called "Processing Profiles" is now available on request.
155 *Swenson Evaporator Co.

Screens, Vibrating.....Bulletin outlines the important new design and high capacities for long life under rugged conditions. Available in all sizes.
222B Safety Industries, Entoleter Div.

Spiral Rake Thickeners.....available in sizes to 150′ diameter. Bulletin No. T5-B6 outlines the application of this equipment in the chemical process industries.
216b *Denver Equipment Co.

Strainers.....Automatic self-cleaning strainers for efficient removal & disposal of suspended particles from raw or process water & other liquids. Bulletin 500.1.
BL219 *S. P. Kinney Engineers, Inc.

Thickeners.....Brochure discusses various types of the manufacturer's thickeners and related equipment. Special models for corrosive, high-pressure service.
222C Process Engineers, Inc.

Turba-Film Processor.....has wide applications in atmospheric and low vacuum ranges. Literature is now available with details for your requirements.
54a *Rodney Hunt Machine Co.

Twin Strainers.....two types available. Also Single Strainers, one type with automatic self-cleaning & other with removable basket for manual cleaning. Complete details.
180 *Elliott Co.

Vacu-Film Processor.....extends the range of thin-film processing into high vacuum...to one-half micron. Literature contains details for your requirements.
54b *Rodney Hunt Machine Co.

Waste Treatment.....Bulletin SM-1005 gives comprehensive information on company's line of clarifier and Oxidator equipment for water, sewerage and waste treatment.
222D Process Engineers, Inc.

* From advertisement, this issue

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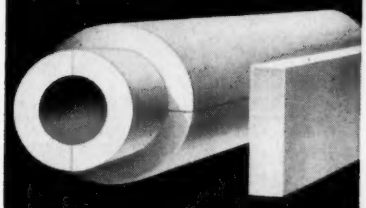

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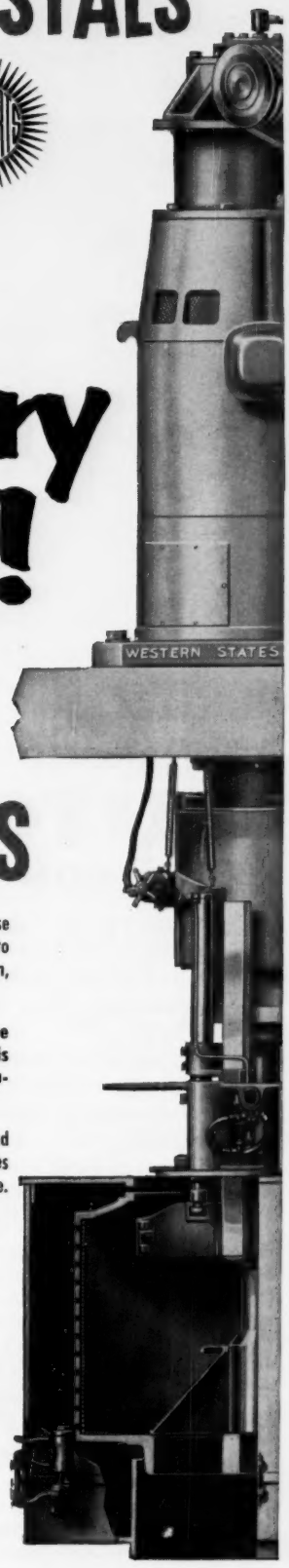

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Is yours one of the growing number of end products whose value **hinges** on perfect crystal structure? Do you strain to form them, only to lose them during centrifuging? Then, by all means, examine the Roberts Centrifugal!

Our slow speed discharge, 35 r.p.m. (in reverse rotation, for safety's sake) enables us to make this promise, unmatched by any other centrifugal manufacturer . . . "NO CRYSTAL DEGRADATION!"

All cycle components are pneumatically operated, too, and this feature eliminates the possibility of introducing impurities into the product through lubrication or hydraulic leakage.

Full information? **FREE!** Ask for Bulletin No. 2775.

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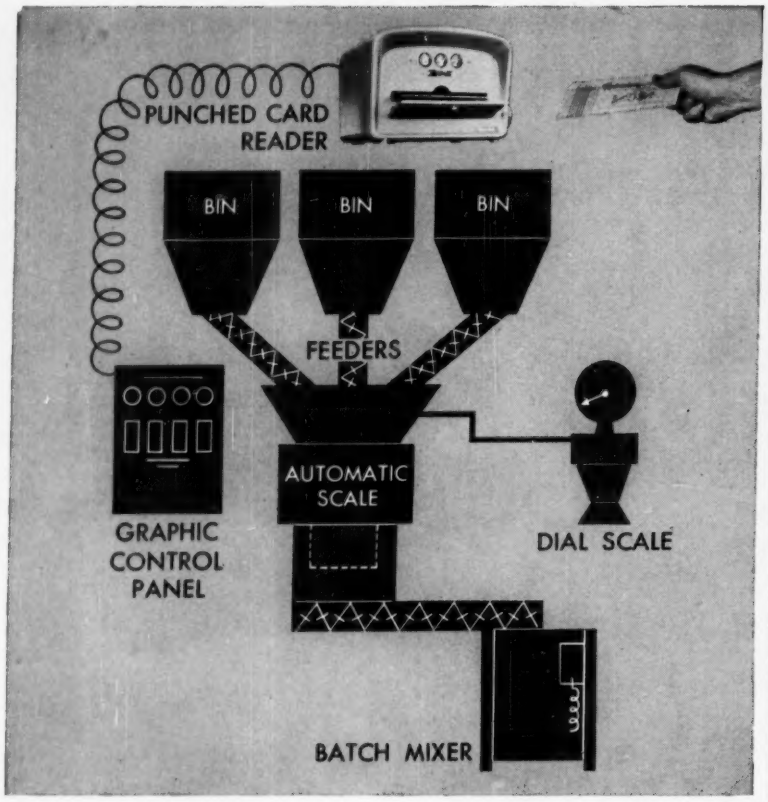
The WESTERN STATES MACHINE COMPANY
Sales Offices New York, N. Y.
General Offices and Plant
1700 Fairgrove Avenue
HAMILTON, OHIO, U.S.A.

2775



RICHARDSON SELECT-O-WEIGH

AUTOMATES

FROM BIN TO BATCH

The Richardson Select-O-Weigh system governs all components required for automatic formulation by weight of any product, liquid or solid, involving any number of ingredients.

Programming – by a Punched Card Reader or alternate control systems

Flow Control and Indication – at one remote control panel, housing complete process circuitry

Feeding – feeders engineered for specific materials and needs

Weighing – by Richardson Automatic Scale, accurate to 1/10 of 1%

Mixing – of ingredients in completed batch

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When required, service is available from Richardson's nationwide network of service facilities . . . within 24 hours. Custom-engineered by the world's foremost manufacturer of automatic weighing and proportioning equipment, Select-O-Weigh helps you make a better, more uniform product, at lower cost. For full details write, wire or call today.

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Sales and Service Branches in Principal Cities

Also Manufactured in Europe to U.S. Standards

1558

Pumps, Blowers, Compressors

Air Separators.....circulate production loads of up to 800 tph. Nine models available with diameters from 3 to 18 ft. Information contained in Bul. 087.
R227 *Sturtevant Mill Co.

Compressor.....The CRX carbon piston compressor does not require oil or water lubrication. Learn the details from Bulletin CRC-10. All types of compressors available.
194 *Gardner-Denver Co.

Compressors.....Full details on how the advanced axial & centrifugal compressor designs can save you money on your compressed air requirements in Bul. 277-11.
32-33 *Joy Manufacturing Co.

Compressors, V-Angle.....Complete details on the Turbocharged V-Angle compressors is now available. Bul. 85 outlines 1100 to 1800 bhp; Bul. 86 outlines 2000 to 3500 bhp.
6-7 *Cooper-Bessemer Corp.

Fans, Corrosion Resistant..... Bulletin F/20 offers complete construction & size selection details. Charts & specifications of all types for handling all corrosive fumes.
224A The Duriron Company, Inc.

Generator, Gas.....for production of oxygen-free gas. Units in capacities of 100 cfh to 10,000 cfh. Complete catalog material & data is available.
8-9a *Engelhard Industries, Chem. Div.

Prefilters.....Bulletin R-35 covers a a line of prefilters for compressed air and gas systems. Maximum handling capacity of units is 11,500 scfm., 270 lb. oil.
224B Desomatic Products

Pump, Vertical.....Illustrated bulletin No. B-505 is available with features of this industrial service pump. Easily adapted for future system requirements.
204 *Food Machinery & Chem. Corp.

Pumps.....Horizontal duplex pumps with piston valve chest adapt to either manual or governor control. Bulletin 230F describes other advantages plus valuable information.
224C Warren Steam Pump Co., Inc.

Pumps.....High-speed Roots pumps give you dry vacuum. Seven models from 74 to 13,000 cfm. Application data and specifications contained in Bul. P8-20.
226 *Consolidated Electrodynamics

Pumps.....Single-stage, end suction pumps are available in capacities from 10 to 200 gpm. Feature vibration free shaft. Descriptive Bulletin No. 500 is offered.
221 *The Weinman Pump Mfg. Co.

Pumps, Glass.....for highly corrosive liquids. Handle temperatures up to 350 F. on all acids except hydrofluoric. Full details in Bulletin 727.3.
120b *Goulds Pumps, Inc.

Pumps, Metering.....An informative new booklet just published, gives all the details on Masterline Metering Pumps...pinpoints the features, etc. Bulletin #900.
77 *Hills-McCanna Co.

* From advertisement, this issue

MANZEL

Here's the most complete, most useful catalog on metering pumps ever published. Lets you select the **exact** unit you need to meet any requirement. Ask your Manzel field engineer . . . or write direct for YOUR FREE COPY.

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DUSTEX miniature cyclone tubes, cast of white iron, provide an ultra-hard, cling-free, self-cleaning surface to assure maximum material recovery at a constant, high-speed rate.

DUSTEX patented design prevents condensation within the collector when inlet temperature is above the dew point. Handles temperatures up to 800°F. There are no filters to clog, no sludge to pump. It's virtually maintenance free!

LOW INSTALLATION COST and up to 99.8% efficiency make DUSTEX the perfect collector for spray dryer, rotary dryer or flash dryer processes.

**Name on request*

Write today for this free bulletin on the new D-584 DUST COLLECTOR.

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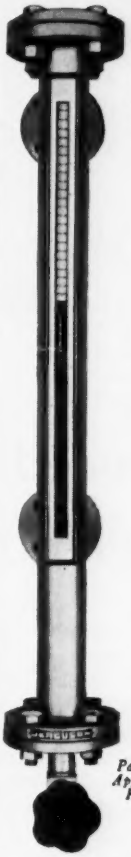
DUSTEX CORP.

Announcing
the New
Jerguson
MAGNETIC GAGE
For Liquid Levels



An important advancement in liquid level observation for plants with dangerous explosive or inflammable conditions.

Safety design seals against escaping gases.

Measuring mechanism in stainless steel chamber.

Scale mounted outside chamber; magnetically actuated through chamber wall.

Distinct, accurate level shown in red contrasted with silver above.

Job designed, correlating pressure, temperature, and specific gravity.

Available with electric alarms.

Patent Applied For

Can also be used for interface indication.

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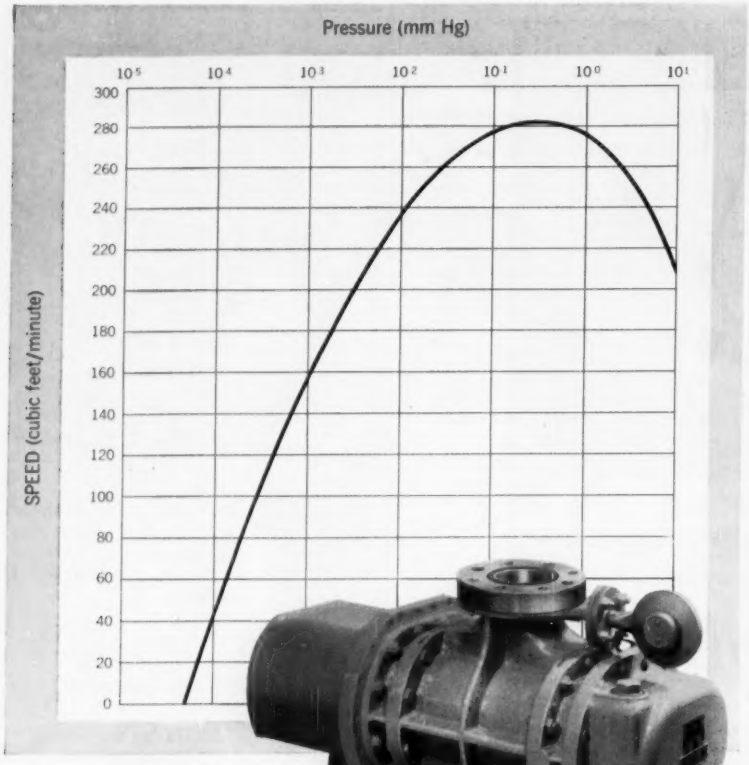

Model VP-R 350A, *one of seven Heraeus (Hanau, Germany) Roots pumps for which CEC is exclusive U. S. agent.*

High-speed Roots pumps give you DRY VACUUM

There's no contamination from backstreaming because Roots pump chambers are completely vapor-free. They use no pump fluid, no steam. Not even sealing oil between impeller blades—unique design engineering eliminates need for it.

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Write for application data and specifications. Just ask for Roots Pump Bulletin P8-20.

Consolidated Electrodynamics

Rochester Division, Rochester 3, N.Y.

SALES AND SERVICE OFFICES IN PRINCIPAL CITIES

LITERATURE . . .

Pumps, Metering.....Complete catalog on metering pumps helps you select the exact unit you need to meet any requirement. Available now on request.
TL225 *Manzel

Pumps, Non-Clog.....Ideal for pumping unscreened liquids with large solids in suspension. Convert between any of the many vertical & horizontal types. Bul. 544OA.
197 *Fairbanks-Morse & Co.

Pumps, Utility.....New catalog describes line of pumps that have no vanes, turbines or impellers. Use helical, turbines or impellers. Use Capacities to 50 gp.n. at 150 psi.
226A Continental Pump Co.

Pumps, Vertical Process.....for handling highly volatile, inflammable, toxic, explosive or other dangerous liquids. Bulletin No. 727.2 gives complete details.
120a *Goulds Pumps, Inc.

Services, Processes, Misc.

Fire Protection.....Illustrated booklet on fire fighting products is offered. Also information on fire fighting systems & all purpose foam systems is available.
75 *Rockwood Sprinkler Co.

Fluidics.....covers such varied phases of fluid handling & control as: corrosioneering, waste treatment, polymerization, fluid analysis, evaporation, drying, etc.
26-27 *Pfaudler Permutit Inc.

Instruments.....8 p. brochure describes the AutoAnalyzer, an automated system for continuous chemical analysis, that can analyze trace materials to parts per billion.
226B Technicon Controls, Inc.

Laboratory Equipment.....Bench-Scale stirred autoclaves for a wide range of pressure reactions. Have a capacity of 300 ml. & pressures up ot 5000 psi. Bul. 1257-1
110 *Autoclave Engineers, Inc.

Laboratory Ware.....All standard forms & sizes for chemical & physical purposes, made of platinum or any desired alloy.
8-9d *Engelhard Indust., Baker Platinum

Lubrication Equipment.....Alemite hand guns & fittings give up to 10,000 lbs. of lubrication pressure. Catalog offered.
35-38 *Stewart-Warner Corp., Alemite Div.

Metals Plating Costs.....New slide chart tells at a glance the cost of metals plating to specified thicknesses. Also gives deposit weights, current densities, etc. $1.00.
226C Sel-Rex Corp.

Safety Equipment.....A complete catalog of flammables safety equipment for the chemical process industries is now available. Includes latest developments.
107a *The Protectoseal Co.

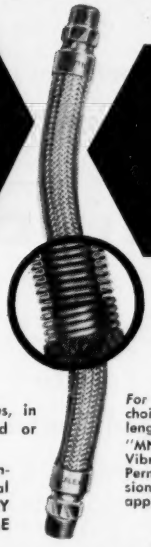
Spectrophotometer.....16 p. brochure describes the Model 4000-A, moderately priced laboratory analytical instrument covering ultraviolet, visible and near infrared regions.
226D **Perkin-Elmer Corp.**

* From advertisement, this issue

NOW Allflex "MNH" FLEXIBLE CONNECTORS

FROM **STOCK** FOR FASTEST SERVICE

- **STAINLESS STEEL**
- **BRONZE**
- **MONEL**



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1/4"	3/8"	1/2"	3/4"
1"	1-1/4"	1-1/2"	2"

IN THESE STOCK LENGTHS

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36"	48"	60"	6Ft.
8Ft.	10Ft.	12Ft.	15Ft.

. . . also available in all standard sizes, in any required length, with any standard or special fitting or flange.

ALLFLEX Standard "MNH" Flexible Connectors are sold through leading Industrial Distributors. If not available locally—THEY CAN BE SHIPPED FROM FACTORY SAME DAY ORDER IS RECEIVED.

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- No more delays while your unit is custom-built.

For the first time, you have an unequaled choice of standard "MNH" sizes and lengths . . . in-stock at all times.

"MNH" FLEXIBLE CONNECTORS: Dampen Vibration. Compensate for Misalignment. Permit Offset Movement. Absorb Expansion. Allow "travel". Handle most flexing applications.

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ALLIED METAL HOSE COMPANY

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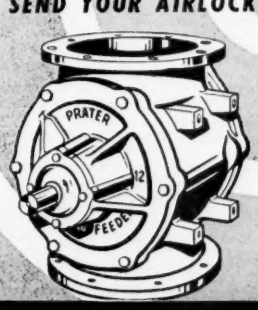
SEND YOUR AIRLOCK FEEDER PROBLEM TO PRATER



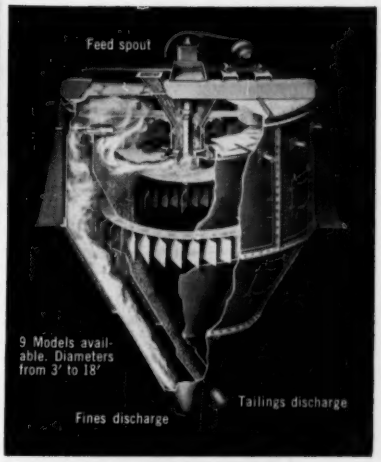
Write for Your Copy of "How to Select a Rotary Airlock Feeder" Bulletin P58

PRATER PULVERIZER COMPANY

1517 SOUTH 55TH COURT • CHICAGO 50, ILLINOIS

Size Requirements Getting Tougher?

Sturtevant Air Separators Increase 40 to 400 Mesh Output as Much as 300%



Closed-circuit air separation is of proved advantage in reduction processes. Result is a better, more uniform product. Grinding mills perform at top efficiency, output frequently increases as much as 300%, power costs drop as much as 50%.

Precise separation of all dry powdered materials. Sturtevants currently classify sulfur, soybeans, phosphate, chocolate, feldspar, sand and aggregates, pigments, limestone fillers, flour, abrasives, plastics, gypsum, ceramics, cement and other products.

Improve screening — Sturtevant Air Separators prevent blinding by removing undesirable tailings *or* fines from screen feed loads.

Works Like Winnowing Done in a Whirlwind

Sturtevant Air Separators do a mechanical job of winnowing. Precise control of whirlwind air currents and centrifugal force results in the desired size being lifted into fines cone, oversize falling into tailings cone.

A 16 ft. Sturtevant, for example, has taken a feed rate of 800 tph, containing only a *small* percentage of desired fines, and delivered 30 tph 90% 200 mesh, recirculating the oversize through the grinding circuit.

Send for Bulletin No. 087.

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Chemical and Mechanical Engineers

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Linde presents challenging projects involving basic studies in thermodynamics, heat transfer, fluid flow, distillation, vacuum technique, equipment design, instrumentation and controls, process engineering, pilot plant design and operation.

These projects, which include research, development and design engineering associated with production and distribution of helium, hydrogen, oxygen, nitrogen and argon as low temperature liquids or gases, are in progress at the Tonawanda Laboratories of the Linde Company.

These Laboratories, one of the largest of the 25 laboratory locations owned and operated by Union Carbide Corporation, are equipped with the most modern engineering facilities. Located one mile north of the Buffalo City limits in the Township of Tonawanda, they are surrounded by many fine residential districts. Nearby Buffalo offers the usual urban advantages. Call or write for appointment and send resume to:

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TONAWANDA, NEW YORK

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Prefer graduate Chemical, Electrical, or Mechanical Engineers with two or three years industrial experience. Trainees will receive intensive training course with daily classroom instruction at Waterbury factory before assignment to district office. Mail reply to H. E. Beane, Vice President.

THE BRISTOL COMPANY
Waterbury 20, Connecticut.

Synthetic Rubber Company needs:

1 Chemical Engineer for shift process control.

1 Chemist with B.S. degree for lab manager. Prefer experience in polymerization. Must be familiar with quantitative and physical analyses and experience in personnel management.

Attractive salaries for those qualified. In replying please state age, education, experience and salary expected.

Write Personnel Manager

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Chemical Engineer—Graduate Chemical Engineer wanted for heading Process Engineering Department with old established Los Angeles processing equipment manufacturer. Experience in drying, dewatering or heat transfer desirable. Exceptional opportunity with a leading, expanding manufacturer. P-9870, Chemical Engineering.

Instrument Engineer for expanding Middle Atlantic States paper mill. Electrical background desirable, minimum three years' industrial experience and college degree required. Excellent opportunity for top-flight engineer. Replies will be treated confidentially. P-9949, Chemical Engineering.

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Manufacturer of Heat Exchangers and Pressure Vessels, located in New Jersey, wants sales representatives in various parts of country. Representatives should have contacts in oil refineries, power plants, chemical plants or marine: RW-8806, Chemical Eng.

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Salaried Personnel $5,000-$30,000. This nationwide service successful since 1927 finds openings in your field. Sells your abilities; arranges contracts. Present position protected. Write for details—Jira Thayer Jennings, P. O. Box 674, Manchester, Vermont.

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Built to your specifications either flat or trough idlers, Timken bearings on head and tail pulleys, all component parts used, rebuilt with new steel structure, new or used belting. Let us quote on your requirements. Sizes 16", 18"; 20"; 24"; 30"; and 36" widths available. Any length.

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1—**LINK BELT** Continuous, 40' H, 35' centers, 10" Belt, 8x5" Buckets, 5 HP Motor.
1—**LINK BELT** 40' H, 35' Centers, 18" Belt, 9x15x7" Buckets, 7½ HP Motor.
1—**LINK BELT** 45' H, 40' Centers, 6-ply 14" W Belt, 12x7" Buckets, 7½ HP Motor.
2—**LINK BELT** 55' H, 50' Centers, 20" Belt, 18x8" Buckets, 10 HP Motor.
2—**NAT'L ENGR'G.** 31' Centers, 14" W Belt, 12x7" Buckets, 5 HP Motor.

CENTRIFUGAL PUMPS

1—**ALLIS CHALMERS** 3 or 4 Stage, 4" Inlet, 3" Outlet, 500# Pressure, 150 GPM. 75 HP Motor & Controls.
1—**WORTHINGTON** Style 5KF365DA7, Size 1½x4, 30 GPM, 1200# Pressure, G.E. 25 HP motor, Ser. #1038687.
1—**INGERSOLL RAND CAMERON** SIZE 4RT-4 Four-stage suction, 450 GPM Pump, 3560 RPM, 1100' Head, 1200# Hydro Test. Reliance 200 HP Motor & Auto. Compensator.

CENTRIFUGAL OIL CLARIFIERS

3—**DeLAVAL** Model 194-61, 3 HP Motor, Ser. #3503702.

CRUSHER

1—**JEFFREY** Double Roll, 20x18", Ser. #7223. New 1951.

MIXERS

3—**BAKER PERKINS** Model 4-A, Capacity 40-60 tons per hour. 100 HP Motor.
1—**JEFFREY** Paddle Type, Continuous, 48"x8' L. 20-Tons per hr., 32.3 RPM, 10 HP Motor & D. O. Jones Reducer, 3-60-220/440 V.
2—**MULTIPLEX** Model MM5M, 4-Paddle Arms, 8-Blades, 3 HP Motor. Ser. #9569.

MIX-MULLERS

2—**CLEARFIELD** Model 404, 24x7" Muller, 4 cu. ft. cap., 5 HP Motor.
3—**CLEARFIELD** Model 610, Enclosed Gear, 30x9" Mullers, 10-14 cu. ft. cap., 15 HP Motor with Bucket Loader.
2—**SIMPSON** Model 1-H, Style K, Enclosed Gear, 400# Batch Cap., 5 HP Motor, w/Dust Hood.
2—**SIMPSON** Model 1¼-UD, Unit Drive, 700# Batch Cap., 7½ HP Motor, with Bucket Loader.
2—**SIMPSON** Model 2-UD, Unit Drive, 14 cu. ft. cap., 20 HP Motor, with loader.
1—**SIMPSON** Model 3, Style C, 3000# Batch Cap., enclosed gears, 50 HP motor.
6—**SIMPSON** Model 3-UD, 3000# Cap., 40 HP Motor.
1—**LANCASTER** Model EBG-4, 5 cu. ft. capacity. 10 HP Motor, with Loader.

VIBRATING SCREENS

1—**HEWITT ROBBINS VIBREX** Screen, Style M7, 35-ton cap., 3'x6½'. 2 HP motor.
1—**JEFFREY** Rotary Sand Screen, 4' dia. x 12' long. 15 HP TECBB Motor.
1—**LINK BELT** Double Deck Sand Screen, 3x8' screen. 5 HP Motor.
1—**NATIONAL ENGINEERING** Hex. Revolving Screen, 3x5x8' L. U. S. 7½ HP Motor.

VIBRATING FEEDERS

5—**JEFFREY** #5, 24" x 7' long.

APRON FEEDERS

1—**PALMER BEE**, 24" wide x 8' centers with Motor & Reducer.
2—**JEFFREY**, 48" wide x 10'6" centers w/motor & reducer.
1—**LINK BELT APRON CONVEYOR**, 24" wide x 303' centers, with motor & reducer.

BALL-MILLS

1—**INTERNATIONAL**. Size 6' x 12', porcelain lined. I.D. 66" x 117". 25 HP gear head motor. New 1954.
1—**INTERNATIONAL**. Size 6' x 8', porcelain lined. I.D. 67" x 91". 25 HP Gear head motor. New 1954.

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1—Bird 32" x 50" solid bowl continuous Centrifuge, 316 S.S.
4—Sharples C20 Super-D-Hydrators, 316 S.S.
2—Sharples PN14 Super-D-Canters, 316 S.S.
1—AT&M 26" suspended Centrifuge, perforated basket, 316 S.S.
2—Oliver 8' x 8' Precoat rubber covered Rotary Vacuum Filters.
1—Oliver 3' x 4' lead Rotary Vacuum Filter
4—Sperry 36" rubber covered Plate & Frame Filters, 30 chambers.
4—Sperry 36" cast iron Plate & Frame Filters, 30 chambers.
4—42" aluminum Recessed Filters, 36 chambers.
4—Shriver 36" wood Plate & Frame Filters, 44 chambers.
5—Struthers-Wells 8' dia. x 24' high rubber lined Vacuum Crystallizers.

PULVERIZERS AND MILLS

4—Mikro Pulverizers, 3TH, 2TH, motor driven.
2—Abbe 5' x 16' brick lined Mills.
3—30"dia. Stainless Steel Micronizers complete with Hoppers, Conveyors, etc.

KILNS AND DRYERS

1—Traylor 11' x 155' Rotary Kiln, ¼" shell welded, 2 tires.
1—Vulcan 8' x 125' Rotary Kiln, ¼" shell riveted, 2 tires.
1—Vulcan 8' x 50' Rotary Kiln, ¼" shell welded, 2 tires.
2—Rennenberg 6' x 60" Rotary Kilns, ¼" shell riveted.
1—Traylor 5' x 50' Rotary Dryer, 716" shell welded, 2 tires.
1—Proctor & Schwartz 8' wide x 60' long Conveyor Dryer, Stainless Steel Belt.

RUBBER LINED TANKS

4—3400 gal. 8' x 8' with Nettco Turbo Agitators, 15 HP motors.
1—4000 gal. 10' x 7'6" with Nettco Turbo Agitator, 10 HP motor.
1—4500 gal. 9' x 9' with Nettco Turbo Agitator, 3 HP motor.
1—5000 gal. 9' x 10' with Nettco Turbo Agitator, 15 HP motor.
5—8500 gal. Vertical Storage, 8'6" x 16' x 8' cone.
1—10,500 gal. Horizontal Storage, 10' x 18'.
1—13,000 gal. Horizontal Storage 8' x 35'.

STEEL TANKS

4—2000 gal. 7' x 7' with Nettco Turbo Agitators, 10 HP motors.
1—3000 gal. 8' x 8' with Patterson Turbo Agitator, 10 HP motor.
1—5200 gal. 10' x 9' with Patterson Turbo Agitator, 10 HP motor.
15—Storage Tanks: 3800; 6000; 9000; 10,000; 15,000; 47,000 gal.

OTHER ITEMS

3—Worthington, I.R. Compressors; 1000, 500 & 365 cfm, 30 psi.
4—Worthington, I.R. Vacuum Pumps, 1000 and 500 cfm.
11—Steel Buildings 20' to 80' trusses.
2—Shepard Niles 20 ton Overhead Cranes.
7—Dorr Thickeners; 16' dia. with Tanks.
1—Bemis 50# Bag Packer with Sewing Machine, Conveyor and Flattener.
125—LaBour, Durco, Worthite, Duriron and Stainless Steel Centrifugal Pumps 2" to 6" with motors.

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The GELB Girl February, 1959

. . . . just had time to make this issue with these GELB equipment specials.

16—Alco type 316 SS Reactors, 3000 gals, complete with agitators and Turbo drives, 50 psi jacket.
19—Robinson type 304 SS horizontal blenders, 255 cu.ft.
1—Bird type 316 SS 48" suspended type centrifuge with perforated basket and fume type cover.
3—Louisville stainless steel rotary dryers, 8' x 50'
3—Pfaudler type 316 SS jacketed reactors, 750 gal.
2—Pfaudler type 316 SS jacketed kettles, 400 gal.
2—Van Alst SS jacketed kettles, 400 gal.
2—Van Alst SS jacketed reactors, 50 gal.
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2—Paddle mixers, 250 cu. ft., T304 SS, jacketed.
2—Dunning & Boschert double paddle, 210 gal., 54" x 47" x 30".
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1—Worthington 70 cu. ft. rotary batch blender, 30 HP.
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2—Sharples PN-14 Super-D-Canters.
7—Sharples #16, T304 SS.
2—Sharples #18V, vapor-tite.
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1—450 gal. reactor T347 SS, 15# jkt., agit.
2—125 gal., T304 SS fermenters, ASME.
1—100 gal. T304 SS reactor, ASME vac. int. 75# jkt. UNUSED.
1—1000 gal. Pfaudler G.L. reactor, ASME 75# jkt., 25# int.
3—750 gal. Pfaudler model "R", glass, jkt. & agit.
1—600 gal. G/L reactor, jkt.
5—500 gal. Pfaudler G/L reactors, 25# int., 75# jkt.
1—30 gal. Pfaudler G/L reactor, 25# int., 75# jkt. Agit.
5—1800 gal. Steel Kettles, 180# jkt., paddle agit.
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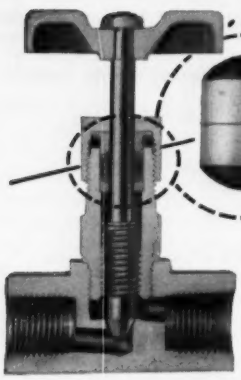

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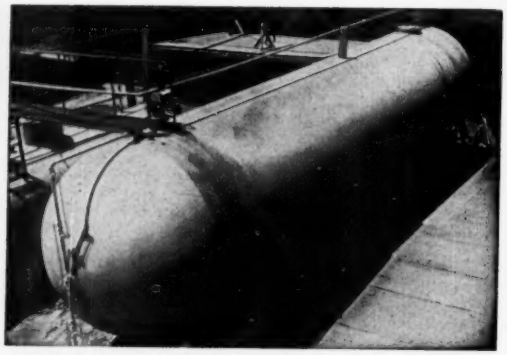

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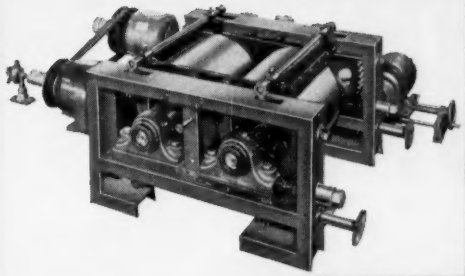

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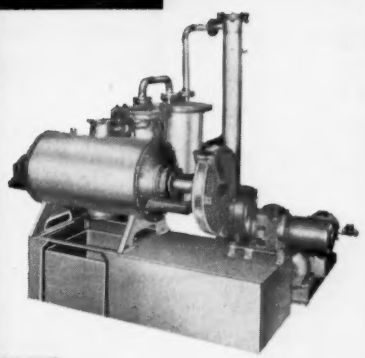

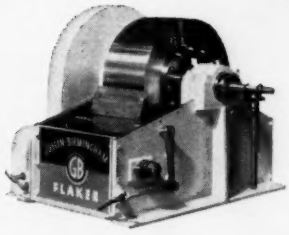

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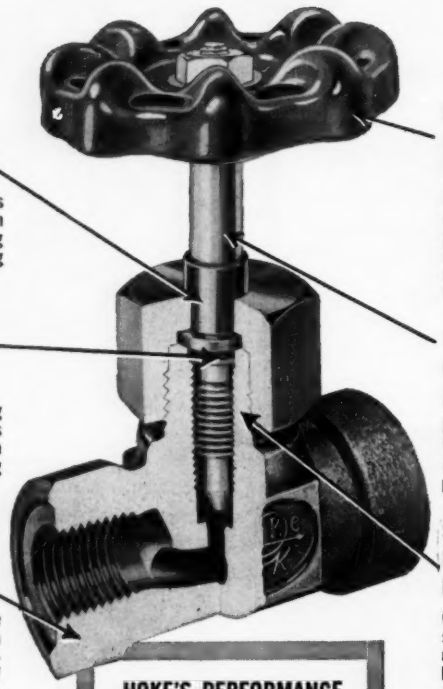

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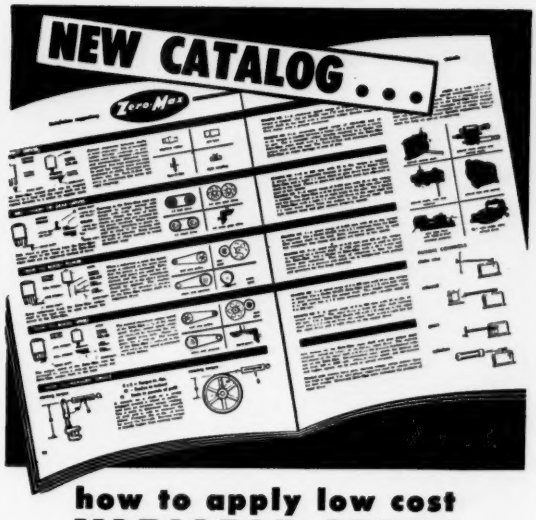

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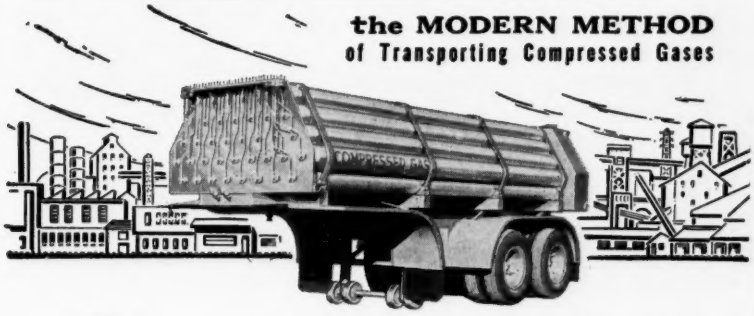

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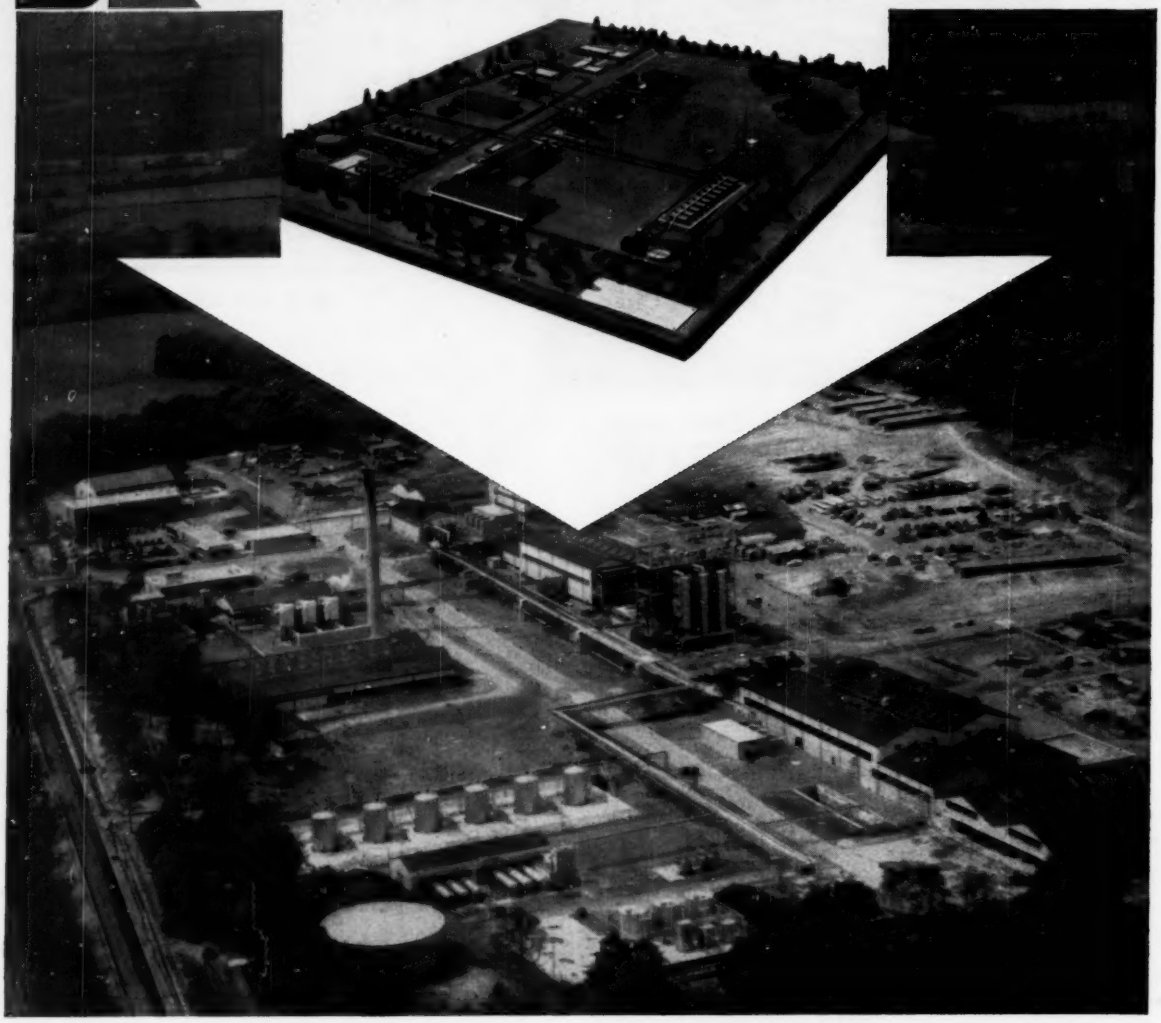

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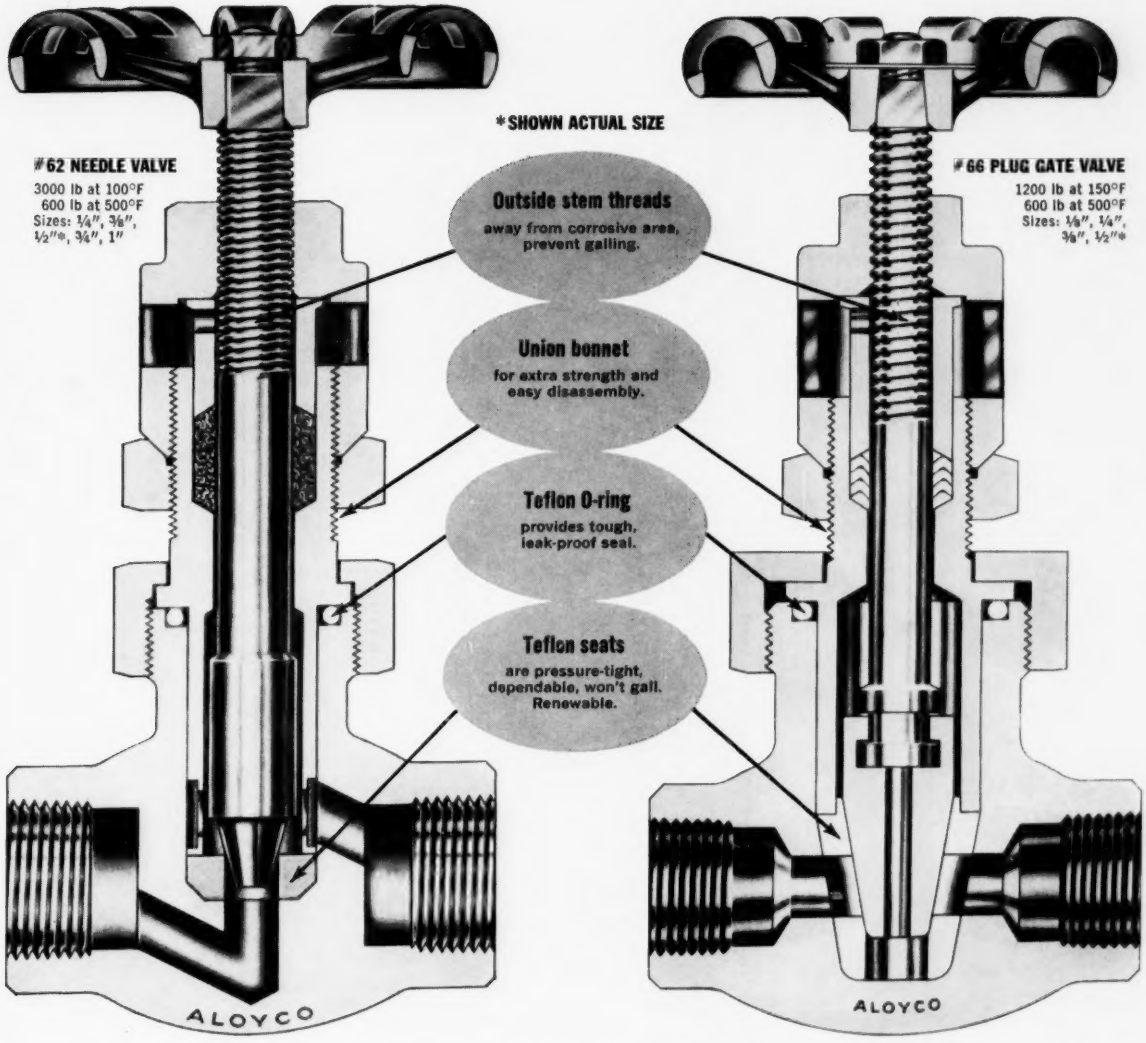

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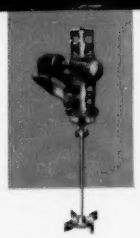


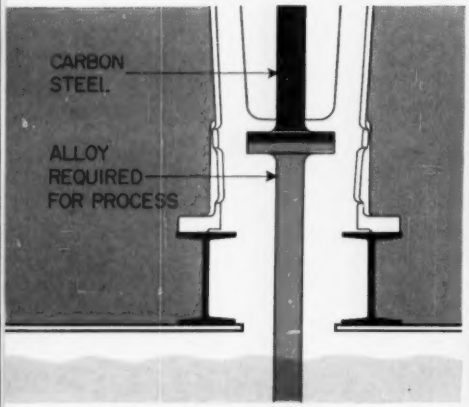
If you want to cut fluid mixing costs
look inside the tank

You can make some of your biggest cost reductions *inside* the tank, when you select a mechanical mixer for fluids.

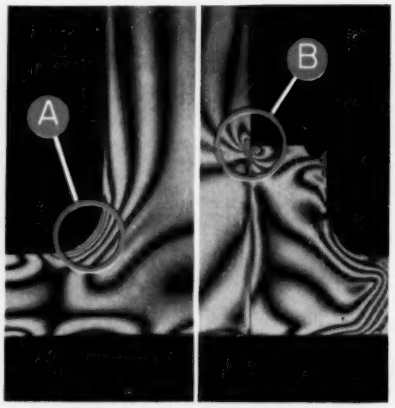
These are *long-term* savings—based on low-cost maintenance, trouble-free service, adaptability to changes in your process, minimum spare-part requirements.

These are the areas where you can *really* save money on fluid mixing. And here are some in-the-tank reasons why you can do it better with LIGHTNIN Mixers than with any other make. For lowest-cost fluid mixing, see your LIGHTNIN representative soon. He's listed in Chemical Engineering Catalog. Or write us direct.

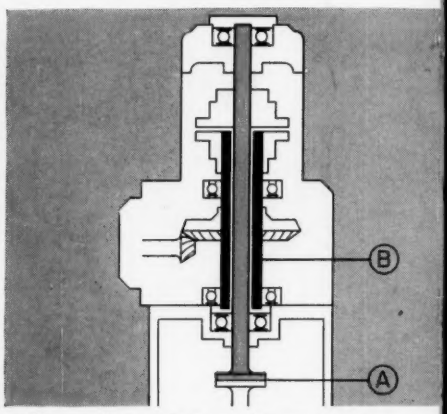
Save 6 ways with these *Lightnin* shaft and impeller refinements



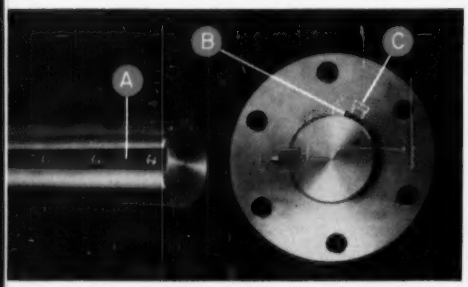
1. Get lower-cost installation, upkeep with two-piece shaft. Standard on open-tank units (available with closed-tank units, too), lower section is alloy required for process; upper section can be inexpensive carbon steel. Rigid coupling has rabbeted joint assuring accurate alignment.



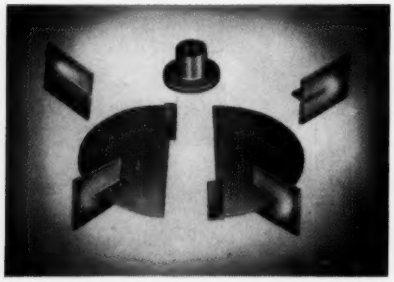
2. You get twice the strength of conventional shaft couplings with LIGHTNIN deep-welded coupling (A). Not one of these couplings has ever failed in service. Polarized light shows how machined and polished radius eliminates stress concentration found in conventional coupling (B).



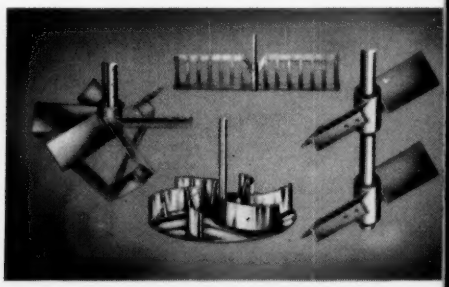
3. No need to disturb gearing if you ever want to replace a LIGHTNIN shaft. Lower shaft is unbolted at (A). Upper shaft slides out of hollow reducer quill* (B). Gears remain untouched—cannot get out of line. When new shaft is installed, shaft alignment is automatic. *Patented



4. Save time positioning impellers. Standard 18-inch shaft keyway (A) provides seven positions (more if you want)—saves you cost of special machining. Also note shallow extra keyway (B) for impeller hub setscrew (C). It permits impeller to slide freely, even if shaft is burred.



5. Cut impeller replacement cost with LIGHTNIN all-bolted design. Replace blades without buying a whole new impeller. Blades come off to pass small openings; or impeller can be supplied split, as shown. Same disc takes 4, 5, 6, or 8 blades for easy change in power input.



6. Get the right impeller for your needs. You can handle practically any fluid mixing requirement with a standard LIGHTNIN impeller. But for special jobs, you can get LIGHTNIN impellers made to specification in all machinable materials and with widest choice of coverings.

WHAT MIXING OPERATIONS ARE IMPORTANT TO YOU? You'll find a wealth of information on fluid mixing in these helpful bulletins describing LIGHTNIN Mixers:

- ☐ Top or bottom entering; turbine, paddle, and propeller types: 1 to 500 HP (B-102)
- ☐ Top entering; propeller types: ¼ to 3 HP (B-103)
- ☐ Portable: ⅛ to 3 HP (B-108)
- ☐ Confidential data sheet for figuring your mixer requirements (B-107)
- ☐ Side entering: 1 to 25 HP (B-104)
- ☐ Laboratory and small-batch production types (B-112)
- ☐ Condensed catalog showing all types (B-109)
- ☐ Quick-change rotary mechanical seals for pressure and vacuum mixing (B-111)

Check, clip and mail with your name, title, company address to:

MIXING EQUIPMENT Co., Inc., 128-b Mt. Read Blvd., Rochester 3, N.Y.

In Canada: Greey Mixing Equipment, Ltd., 100 Miranda Ave., Toronto 19, Ont.

Lightnin® Mixers

MIXCO fluid mixing specialists